SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1909.

GENERAL PHYSICS.

1482. *Fatigue Testing Machine.* **J. H. Smith.** (Engineering, 88. pp. 105–107, July 23, 1909.)—Gives a detailed description of the latest form of the machine referred to in Abstract No. 928 (1905). When either of the two specimens breaks the machine stops by means of a cut-out with an indicator to show whether rupture occurred in tension or compression. For long specimens a special chuck is used, which prevents buckling in compression. A mirror extensometer measures the extensions to 1/40000 in.; and an apparatus is described which gives oscillograph stress-strain diagrams. Hysteresis loops are in this way obtained on long specimens. The machine is designed for ranges of stress up to 60 tons per sq. in., and speeds up to 1,000 r.p.m. F. R.

1483. *A New Form of Micro-barograph.* **T. Shida.** (Mathematico-Physical Soc., Tokyō, Proc. 5. 4. pp. 76–81, April, 1909.)—An aneroid barometer is used to show small variations of atmospheric pressure. The necessary sensitiveness is obtained by using a bifilar suspension. The Bourdon tube of the aneroid is bent so as to form almost a closed circle, and the threads which support the mirror are attached to prongs fixed on the fore ends of the tube. The recording is photographic. A magnification of the barograph scale of 400 or 500 is obtained in this way. R. G. K. L.

1484. *Electrical Device for Evaluating Formulæ and Solving Equations.* **A. Russell** and **A. Wright.** (Phil. Mag. 18. pp. 291–303, Aug., 1909.) Paper read before the Physical Society. Electrician, 63. pp. 903–904, Sept. 17, 1909. Abstract.)—The instrument described was invented by A. Wright, and it combines the principle of the ordinary logarithmic slide-rule with addition and subtraction, by utilising the laws according to which resistances combine in series or parallel. The products found by the slide-rule method are represented either by the resistances or by the reciprocals of the resistances of certain wires. In the latter case the currents through them can easily be added or subtracted by a Wheatstone-bridge method. Hence the sums or differences of the products can be found. For description of the special resistances employed and the method of use for evaluation of formulæ and obtaining roots (real and imaginary) of miscellaneous equations the original paper should be consulted. The present apparatus gives accuracy of the order of 1 per cent., but this could be increased with more careful construction. A. W.

1485. *Variation in Specific Gravity of Italian Bronze and Silver Coinage on Heating and Rolling.* **E. Pannain.** (Accad. Lincei, Atti, 18. pp. 700–701, July 20, 1909.)—The author has determined the specific gravity of bronze and silver coinage at various stages of its treatment at the Mint at Rome. The following are the results:—

	Bronze.		Silver.	
	Specific Gravity.	Difference.	Specific Gravity.	Difference.
Alloy, fused	8·76965	—	9·99932	—
Alloy, fused, heated	8·77102	+0·00137	10·00206	+0·00274
Alloy rolled after heating	8·93920	+0·16818	10·20244	+0·20038
Alloy heated after rolling	8·94031	+0·00111	10·20251	+0·00007
Alloy again rolled	8·94198	+0·00167	10·20759	+0·00508
Alloy heated after second rolling	8·94617	+0·00419	10·21648	+0·00889
Alloy coined	8·94623	+0·00006	10·21636	−0·00012

The alloys have already been microscopically examined at each stage [see Abstracts Nos. 567 and 1465 (1909)]. W. H. Sı.

1486. *Non-Newtonian Mechanics.* **G. N. Lewis.** (Science, 30. pp. 84–86, July 16, 1909.)—Assume (1) conservation of mass; (2) centre of mass of a system remains at rest unless external force acts; (3) reaction during radiation produces opposite momentum $= E/V$, where E is the energy emitted and V the velocity of light (Maxwell, Boltzmann; Nichols and Hull experimentally); and (4) if a body suffer a mere loss of energy through radiation, and if then the same amount of energy is returned to it, the system will return to its original condition. Let a body radiate away energy E; it acquires backward momentum $m'v = E/V$; to keep the centre of mass of the system in the same place the radiation must have a mass m such that $mV = m'v$; whence $m = E/V^2$ the mass in the radiation. This mass must come from the emitting body, and if the emitting body regain its energy it will regain its mass; hence $dm = dE/V^2$, and if a body in motion has more energy than one at rest, it must also have a greater mass; whence m_v being the mass of a body in motion with velocity v, and m_0 its mass when at rest, $m_v/m_0 = (1 - v^2/V^2)^{-\frac{1}{2}}$. This equation, as regards the mass of a β-particle, has been experimentally verified by Bucherer [Abstract No. 1993 (1908)]. If a velocity $v = V$ could be obtained in experimental mechanics, the moving mass would have infinite mass and infinite energy; but it would take infinite work to bring any body to this velocity, which is therefore not realisable. A. D.

1487. *Matter and Mass.* **L. T. More.** (Phil. Mag. 18. pp. 17–26, July, 1909.)—Criticism of recent theory, particularly as developed by G. N. Lewis [Abstract No. 11 (1909)]. It is not necessary to assume that radiation is due to a mass in motion merely because energy is involved in radiation and a black body absorbing this energy is moved mechanically; electromagnetic waves would have this effect (Maxwell); and the assumption is contrary to mechanical experience, and is arbitrary. It is experience which decides what are the constants in our mathematical expressions; if otherwise, we might equally well infer that mass is a function of the position of a body, but experience teaches differently. The sun, if on losing energy it loses mass, must be losing $1{\cdot}2 \times 10^{20}$ gm. mass per annum; and the mass of a beam of light must be infinite and yet vanish when the light impinges. The new ideas are on all fours with the well-established effective or apparent increase of mass in hydrodynamics, which arises from constraint in the liquid: the fluid pressure acts as if it had increased the true inertia of the moving body. Kelvin's vortex theory of atoms failed because the effective inertia of the vortex ring was not invariable, but dependent upon the position and influence of its neighbours. All the attempts—Boscovich's centres of force, vortices, charges of negative electricity, ethereal radiations, the "something in a beam of radiation," and others—to explain the nature of atoms and their mutual forces deal with a transfer of energy, and they either tacitly or openly postulate the existence of invariable inertia in something tangible or intangible. A. D.

1488. *Principle of Relativity, and Non-Newtonian Mechanics.* **G. N. Lewis** and **R. C. Tolman.** (Amer. Acad., Proc. 44. No. 25. pp. 711–724, July, 1909. Research Lab. of the Mass. Inst. of Technology, No. 42.)—All attempts to determine absolute velocity in the ether of space have failed. Einstein (Jahrb. d. Radioaktivität, 4, 411, 1907) has assumed (1) that absolutely uniform translatory motion can neither be detected nor measured, and (2) that the velocity of light in free space appears the same to all observers, regardless of the motion of the source of light or of the observer. From these, which together form the "principle of relativity," along with the electromagnetic theory, Einstein has deduced a series of consequences including G. N. Lewis' non-Newtonian mechanics. The same consequences, it is now shown, can be deduced from the conservation laws and the principle of relativity, without reference to electromagnetic theory. These include apparent changes in the units of time and length according to the position of the standards and the observers with reference to the direction of motion relative to some point arbitrarily chosen as a point of rest; an apparent change of mass increasing with velocity relative to any point arbitrarily assumed as a point of rest; similar apparent changes in the unit of force; kinetic energy imparted to a body by setting it in motion is equal to $V^2 \times$ the additional mass imparted to it by giving it this additional energy; and kinetic energy is a "second order effect" of the same character as the change of length and the change of mass, but is extremely minute in comparison with the total energy of the systems investigated. A. D.

1489. *Pressure Surface.* **A. N. Dinnik.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 1. pp. 57–62, 1909.)—The author studies, theoretically and experimentally, the pressure surface of a sphere falling on to a plane surface with a known velocity. Neglecting that portion of the kinetic energy of the sphere which is converted into vibrational energy, that is, assuming that all the energy is converted into potential energy of compression of the sphere and plane, the radius, a, of the pressure curve is, according to Hertz, given by the expression $a = \sqrt[3]{8p(1-\sigma^2)R/2E}$, where R is the radius of the impinging sphere, E Young's modulus, σ Poisson's constant, and p the pressure of the sphere on the plane surface. Since $m = 4\pi R^3 q/3$, the above expression becomes $a = R\sqrt[5]{5\pi q v^2 (1 - \sigma^2)/2E}$, which may be further simplified by putting $\delta = 4(1 - \sigma^2)/E$ to $a = R\sqrt[5]{5\pi q . \delta . v^2/8}$. The value of δ may be calculated from the equation $\delta = 8a^3/3Rp$. The values of a calculated in this way are in good agreement with those obtained by experimental measurement. For a steel ball, $R = 1{\cdot}277$ cm., impinging on a steel plate with a velocity of 100 cm. per sec., a (calc.) = 0·062 cm. and a (obs.) = 0·063 cm. When the impinging substances are of different materials, the equation for a becomes: $a = R\sqrt[5]{5\pi q(\delta_1 + \delta_2)v^2/16}$. For steel and glass $\delta_1 + \delta_2 = 7{\cdot}42 \times 10^{-13}$, and the calculated value for a, when $v = 100$ cm. per sec., is 0·072, the corresponding observed value being 0·066. The results obtained with two steel cylinders, impinging perpendicularly, are also in good agreement with the theoretical numbers. Thus, when $R = 2$ cm. and $v = 40$ cm. per sec., a is calculated to be 0·088, the observed value being 0·090. T. H. P.

1490. *Notes on Tests for Hardness.* **T. Turner.** (Iron and Steel Inst., Journ. 79. pp. 426–437; Correspondence, pp. 438–443, 1909. Abstracts in Engineering, 87. pp. 835–836, June 18, 1909. Metallurgie, 6. pp. 371–376, June 8, 1909.)—Hardness may be defined as the property of resisting penetration, and becomes manifest in various ways according to the acting stress, *e.g.*, tensile hardness, cutting hardness, abrasion hardness, elastic hardness, and dynamic hardness, according as conditions bring into operation properties other than that of simple mineralogical hardness. Dynamic hardness, resistance to penetration by a moving body such as effect of a sand blast, has received little attention. Hardness varies inversely as the atomic volume in the case of pure metals, and in alloys of metals forming solid solutions the hardness increases with the osmotic pressure. If a continuous series of solid solutions is formed, the point of max. hardness generally corresponds to the minimum of electrical conductivity. The author selects the following as four typical methods of determining hardness: (1) Turner's sclerometer; (2) Shore's scleroscope; (3) Brinell's test; and (4) Keep's drill test. In the sclerometer test a weighted diamond point is drawn backward and forward once over a smooth surface of the material under test, the weight in gm. required to produce a standard scratch, giving the hardness number. The difficulties lie in obtaining a smooth reflecting surface and in recognising the standard scratch. Shore's scleroscope allows a cylindrical hard-pointed hammer to fall on a smooth surface, the hardness being measured by the rebound. This test is simple and rapid, but gives peculiar results demanding further study, *e.g.*, indiarubber gives a rebound of 23, equal to that of mild steel, soft pine wood 40, and teak 23. The results depend upon the thickness of the material and the nature and thickness of the support. A sample of brass, which gave a hardness of 17, would scratch copper which gave a hardness of 30–34 according to the nature of the support, but the copper would not scratch the brass. The method seems to determine elastic hardness, and gives high results with hard-worked materials. Brinell's test is the standard one but cannot be applied to very brittle materials, while Keep's test is specially suitable for castings but cannot be applied to materials harder than hardened steel. For pure metals there is a remarkable general agreement in the proportionality of the results given by the four methods. The Shore and Brinell methods show considerable differences between the hardness of hard-drawn and soft materials—a difference hardly indicated at all by the sclerometer method. It appears that hard working increases the tenacity out of all proportion to the increase of file-hardness, consequently tests following the tenacity may be expected to show exaggerated hardness for hard-drawn materials. Further, the methods show considerable differences in the loss of quenching hardness experienced on tempering hardened steel.

F. C. A. H. L.

1491. *End Friction in Compression Tests.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 29. pp. 432–444, 1908–1909.)—With end-plates harder than the (short) test specimen there is an increase in the apparent yield-point, which amounts to about 18 per cent. for wrought iron and mild steel, 20 per cent. for cast iron, and 50 to 200 per cent. for stones, bricks, and concrete, as calculated from angles of fracture. These figures, except for the plastic materials, may apply almost equally well to ultimate strength, but experimental verification is lacking. The corresponding values of the inclinations of the surfaces of shearing are 37° for wrought iron and mild steel, 36° for cast iron, and 27° to 15° for stones, &c.; the first of these is seldom obtained, however. When the end-plates are softer than the material tested the strength of stones is calculated as 0·85 to 0·15 of the value when iron end-plates are used. Experiments give the value 0·65 to 0·48, but the specimens do not fail by shearing as contemplated. The strength of cast-iron compression-pieces ordinarily works out higher the shorter the piece, but the actual stress calculated as ultimate load per unit of area at the centre after fracture is less for short than for longer specimens.

F. R.

1492. *Strength of Riveted Joints.* (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1019–1025, June 26, 1909. Second Report of the Versuchskommission des Vereines deutsch. Brücken- und Eisenbaufabriken.)—In tests of butt joints the greatest strength was given by joints made in a lever machine driven by compressed air. Hand-hammered and air-hammered joints gave less strength and were about equal to one another on the average. The use of countersunk holes and correspondingly formed rivets had no regular influence upon either the slipping resistance or the ultimate strength of the joints. Tensile shock tests of rivets were made by attaching a length of bar to each of the two riveted plates and proceeding as in ordinary tensile shock tests. Whether the common or countersunk rivets were used, the heads always sheared off from the shanks, and in no respect is the countersunk type superior to the ordinary form. It is concluded that the very slight rounding of the corner under the head usually found in commercial rivets, together with the mere removal of the sharp edges of the holes, is all that is necessary, and is recommended for adoption, and in the committee's further experiments no countersunk rivets will be used.

F. R.

1493. *Nickel Steel Eye-bars.* **W. R. Webster.** (Amer. Soc. Civil Engin., Proc. 35. pp. 276–288, March, 1909. Eng. Record, 59. pp. 701–702, June 5, 1909.)—As a result of tests by the American Bridge Co. and the author preparatory to the manufacture of the nickel steel eye-bars for the Blackwells Island Bridge, the ultimate strength of unannealed test-pieces is specified at 95,000 to 110,000 lbs. per sq. in., and of full-size eye-bars at 80,000 lbs. per sq. in., with 48,000 lbs. per sq. in. elastic limit. 9 per cent. elongation in 18 ft. can readily be met. The original paper, not printed in full, contains the detailed results of 47 tests of built-up eye-bars of high carbon and nickel steel. [See also Abstract No. 546 (1908).]

F. R.

1494. *Position-finding without an Horizon.* **C. V. Boys.** (Nature, 81. pp. 111–118, July 22, 1909.)—For such situations as being in a balloon out of sight of land an approximate estimate of position may be of extreme value. Suppose the observations have an error of about the diam. of the sun or moon (32′ of arc), then the resulting uncertainty would be about 30 miles. For this purpose the observation of the altitude and azimuth of a single star will be sufficient. An instrument is proposed, consisting of a vertical collimator suspended on gimbals, and top-weighted like a metronome, so as to have a period of swing either way of about 1 second. The collimator has at its focus a scale of tenths of a degree in transparent divisions on an opaque ground, and above its lens a clear or half-silvered mirror set at 45° with the axis of the collimator. The collimator is carried in a tube which acts as the handle of the instrument, and carries the usual parts of a small sextant. It is found by practice that the readings can be made to 1′. C. P. B.

1495. *Counterbalancing of Rotating Masses.* **J. W. Cloud.** (Engineering, 88. p. 47, July 9, 1909.)—The author has constructed a gyroscope having two equal rotatable masses on the same or parallel axes. When both masses are caused to rotate in the same direction we get the usual effects of the deflecting couples shown by the gyroscope; when the masses are caused to rotate at the same speed but in opposite directions the deflecting couples entirely disappear; when rotated in opposite directions at unequal speeds there is only a partial counterbalancing. When the rotating masses are on parallel axes it is necessary that the frame between such axes should be sufficiently rigid to transmit the counterbalancing forces without vibration, if it be desired to wholly eliminate the effects of the deflecting couples whenever the direction of the axes of rotation is changed. The author points out the importance of these facts in connection with the construction of turbine-driven steamships and twin-screw steamships of the reciprocating type. In rough seas much of the vibration, usually attributed to other causes, has been caused by these deflecting couples, which are at least partially counterbalanced by the opposite rotation of parallel shafts, but with frames of insufficient rigidity to prevent vibration. W. C. S. P.

1496. *The Damping of Mercury Waves.* **R. W. Wood.** (Phil. Mag. 18. pp. 194–195, July, 1909. Phys. Zeitschr. 10. pp. 429–430, July 1, 1909. Translation.)—The author found that waves on the surface of mercury can be quite got rid of by covering the surface with glycerine. Later castor oil was found to be preferable, as it is as viscous and does not produce bands through absorption of moisture from the air. The oil can be obtained water-clear, and it is as efficient as glycerine for damping the waves. The action was investigated by producing waves on the surface of mercury by means of a tuning-fork; light from a source of radiation was then allowed to fall on the surface after being made somewhat convergent by a lens. When the mercury surface was then covered by a thin layer of glycerine or castor oil it was seen that the waves were cut off after traversing a space of from one to three wave-lengths, according to the amplitude of the exciting tuning-fork. A photographic picture of the damped waves is given. J. J. S.

1497. *Viscosity of Water.* **R. Hosking.** (Phil. Mag. 18. pp. 260–268, Aug., 1909.)—The author has examined his previous results [see Abstract No. 976 (1909)] and now gives the following values for the viscosity of water in c.g.s. units: At 50°, 0·005500; at 25°, 0·008926; and at 0·05°, 0·017897, the last value reducing to 0·017928 at 0°. All the author's previous work has been revised, the observations being again reduced by applying in the reduction formula (*loc. cit.*) the value $m = 1{\cdot}158$ instead of 1·000, and the value $n = 1{\cdot}64$. The formula which best fits the results is of the form—

$$\eta_t = \eta_0/1 + \epsilon_1 t + \epsilon_2 t^2,$$

but it is found that the range of temperature for each set of constants must not be greater than 25°. The following are the values of the constants for various temperature intervals :—

	ϵ_1.	ϵ_2.	η_0.
0–25°	0·03455	0·000235	0·017928
25–50°	0·03544	0·000195	0·017928
50–75°	0·0364	0·000175	0·017928
75–100°	0·0390	0·000142	0·017928

The values taken from the experimental curves are in good agreement with those calculated by means of the above formula. T. H. P.

1498. *Determination of a Constant in Capillarity.* **R. D. Kleeman.** (Phil. Mag. 18. pp. 39–44, July, 1909.)—The Helmholtz equation $E + T d\lambda/dt = \lambda$ gives the relation between the increase in the energy in the surface film of a liquid, the external work and the heat absorbed. The value of E has been shown by Whittaker [Abstract No. 1568 (1908)] to be equal to $E = KTL$, where L is the internal latent heat of evaporation at the temperature T, and K is a constant, which differs for different liquids. With the help of the surface energy equation, $\lambda v^{2/3} = A(T_c - T - a)$, the author now deduces the formula $K = Mm^{1/3}\rho_c^{2/3}/T_c$, where M is a constant for all liquids, m is the molecular weight, and ρ the critical density. From this equation, therefore, one can obtain the values of $K = E/LT$, and hence the value of L. A. F.

1499. *Diffusion of Ions through Metals.* **G. Moreau.** (Comptes Rendus, 149. pp. 118–120, July 12, 1909.)—At ordinary temperatures metallic plates are impermeable to ions in a gas, but when the mass of the ion becomes small enough and its velocity sufficiently great, or when the temperature of the metal is raised, this is no longer the case. The present experiments prove that a layer of hot metal may be easily traversed by the negative ions produced in a flame. Two flames, F and f, are burning vertically in contact with a metal sheet M. In the flame F a horizontal electric field X carries the negative ions from M towards a platinum electrode P. The corresponding current is measured by a galvanometer. When a particle of a sodium salt is introduced into the other flame f the current is considerably increased, but very little increase takes place if the field is reversed. This filtration of the negative ions may be compared with the diffusion of a gas through a porous partition. If N and n are the densities in volume of the ions in f and F respectively, $a(N - n)$ negative ions penetrate per sec. into the flame F, where they are caught by the field X. If this field be strong enough $I = a(N - n) = nKX$, where K is the velocity of the negative ion in the flame

F. From these two equations we have $\gamma = B + AV$, in which $\gamma = V/I$, $X = V/d$, $B = d/NK$, $A = 1/Na$, and V = p.d. between P and M when a distance d apart. The equation $\gamma = B + AV$ is completely verified by experiment. It is found also that for a given layer of metal a is a magnitude independent of X, that is, the velocity of diffusion is proportional to the difference in the pressures of the ions on the two sides of M. The velocity a varies with the nature of the metal, its thickness, and its temperature; thus—

Metal.	Thickness, mm.	Temp., Cent.	a in cm. per sec.
Platinum	0·1	860°	$4{\cdot}90 \times 10^5$
Nickel (annealed)......	0·45	740°	$6{\cdot}20 \times 10^5$
Cobalt......................	0·5	710°	$1{\cdot}40 \times 10^5$
Iron.........................	1·6	640°	$2{\cdot}60 \times 10^5$
	8·2	620°	$1{\cdot}60 \times 10^5$
Brass	4·0	510°	$0{\cdot}98 \times 10^5$

If the metal plate does not stop any of the ions which traverse it, then a should be equal to $6{\cdot}8 \times 10^5$ approximately, from which it follows that Pt and Ni are particularly porous to the negative ions. a diminishes very rapidly with the temperature, but it is possible to notice a sensible diffusion through 4 mm. of brass at 270° C. A. E. G.

1500. *Experimental Determination of the Velocity of Fall of Raindrops.* **W. Schmidt.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 71–84, Jan., 1909.)—The apparatus consists of two discs fixed 20 cm. apart on a vertical axis. The upper disc is 40 cm. in diam., the lower one 80 cm. A sector of 15° is cut out of the upper disc. If the apparatus is exposed to rain while at rest in still air, the drops which pass through the sector strike the lower disc vertically below the sector. If the discs are made to rotate, the point at which a drop strikes the lower disc is displaced with regard to the sector, and from the amount of displacement and the known rate of revolution of the apparatus the rate of fall of the drop can be calculated. The positions of the drop on the lower disc are determined by mounting specially prepared filter paper over the disc. The weight of water in the drop, and hence its diam., can be inferred from the size of the "splash." The experiments are conducted in the open air at the bottom of a light-well. Suitable corrections were applied for the effect of air drawn into the rotation (which was found to be small) and other sources of error. Experimentally determined velocities are given for drops varying in radius from 0·198 mm. to 1·67 mm. The max. velocities are about 8 m./sec. For drops of radius greater than 0·9 mm. the observed velocities agree closely with those found by Lenard (Meteorolog. Zeitschr. p. 249, 1904. For smaller drops Schmidt's values are smaller. The observed velocities agree very closely with those given by the formula $1/v = 0{\cdot}00787/r^2 + 0{\cdot}159/\sqrt{r}$, v being measured in m./sec., r in mm. R. G. K. L.

1501. *The Earthquake in Provence of June* 11, 1909. **L. Fabry.** (Comptes Rendus, 149. pp. 170–172, July 12, 1909.)—The general phenomena suggest the action of a vertical blow, as if a ram had struck the earth's crust from below. Although the territory is cut by railways and high roads in all directions, there is nowhere any indication of noteworthy level changes; in some spots railway lines have sunk a little, but not in cuttings and where the rails rest directly upon the soil. The centre of the disturbance seems to have been between Salon and Lambesc at the village of Pélissanne, where the houses appear to have been struck from below; in other spots the blow was apparently oblique, and the complex effects would depend upon the nature and inclination of the ground. The ground seems itself to have become electrified by friction. H. B.

1502. *Determination of Tidal Constants with Horizontal Pendulums.* **J. P. van der Stok.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 2–11, June 25, 1909.)—Analytical discussion of tidal deformation detected by horizontal pendulums, with comparisons of the results recently obtained by Hecker. It is found that if monthly means of the diurnal variation are available, calculated over a great number of years, by preference over years in which the declination of the moon is large, the calculation of the small tide can be made with considerable accuracy. C. P. B.

1503. *Determinations of the Temperature of the Sun.* I. **A. Amerio.** (N. Cimento, 17. pp. 308–327, May–June, 1909.)—The author discusses critically the various methods employed for determining the temperature of the sun, and then describes the apparatus he has arranged for this purpose. A plane silver heliostat throws the light on to a concave mirror of 1 m. focal length, from which the rays are reflected on to another concave mirror S_1 of 12 cm. focal length, and this gives a real image of the sun in any desired position on a black screen by means of two screws which orientate the mirror S_1. In the centre of the screen is arranged the slit of a spectro-bolometer, and on it nine rings are traced in such a manner that, when the solar disc covers one of these exactly, the rays falling on the slit come either from the centre of the disc or from a point on the solar surface 30°, 45°, 60°, or 75° from either side. The rest of the apparatus consists of a Wheatstone bridge and of a galvanometer. The author's first results are to be published shortly, his apparatus having been destroyed during the earthquake at Messina. T. H. P.

1504. *Comparative Spectra of Centre and Edge of Sun.* **H. Buisson** and **C. Fabry.** (Comptes Rendus, 148. pp. 1741–1744, June 28, 1909.)—Various differences are found on large-scale spectra of the sun's centre and limb. Hale and Adams found very marked differences in the intensities of many of the lines, chiefly in the direction that "spot lines" were intensified at the limb; Halm found evidence of a slight increase of wave-length for some rays in passing from the centre to the limb spectrum. The authors have applied their interferential method to the problem, and in their preliminary results they find that on passing from the centre to the edge the spectrum lines are in general shifted about 0·005 Å.U. towards the red, and widened about 0·010 Å.U. It may be that these two effects are really one, viz., a displacement of the red side of the line only, the violet side remaining constant. Notable exceptions occur with lines of vanadium, which enlarge symmetrically. A pressure of 7 atmos. is mentioned as sufficient to account for the observed displacement. C. P. B.

1505. *Polarisation of Solar Corona.* **Salet.** (Bull. Soc. Astronom. France, June, 1909. Nature, 81. p. 46, July 8, 1909. Abstract.)—Discussion of photographs obtained during the total solar eclipse of Aug., 1905, with a polariscope camera. Evidence of polarisation was shown in the coronal matter quite to the moon's limb. The author thinks that the bright radiations observed with spectroscopic apparatus may be due to metallic vapours rendered fluorescent by the intense solar radiation. C. P. B.

1506. *Physical Interpretation of Lunar Features.* **P. Puiseux.** (Comptes Rendus, 148. pp. 1744–1746, June 28, 1909.)—From a study of the photographs of the eleventh volume of the Paris Observatory lunar atlas it is found that the moon does not show regions of special nature about its poles, such as is noticeable on the earth, Mars, Jupiter, and Saturn. Regions of special brightness are found both near the poles and in the equatorial zone, and it would appear that the tint of the surface is independent of the latitude, but may have a slight relation to the altitude above the mean ground-level. Reference is made to relative albedoes of glacier formations, volcanic detritus, and meteoric dust as explanatory of the white colour of the lunar surface. C. P. B.

1507. *Saturn and its Rings.* **J. Schaer.** (Astronom. Nachr., No. 4331. Nature, 81. p. 20, July 1, 1909. Abstract.)—Details of observations of the planet's system with a special Cassegrain reflector, 40 cm. aperture, during the period 1908, Sept. 18, to 1909, Jan. 24. The chief feature is the account of the discovery of a new dark ring on Oct. 7, 1908. The possibility of a cloudy absorbing atmosphere is also suggested, and slight changes in the white ring between the crape ring and Cassini's division. C. P. B.

1508. *Bearing of Recent Observations on the Disappearance of Saturn's Rings in 1907.* **E. E. Barnard.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 621–624, June, 1909.)—The new dark ring exterior to the bright rings of Saturn discovered by Fournier at Mont Revard in 1907, Sept., was carefully searched for by the author on 1909, Jan. 12 and 19, under good conditions, with the Yerkes 40-in. refractor, and nothing suggestive of its existence was seen. It was not seen by him in 1908, when the rings were carefully observed several times. It might at first have escaped notice through its existence being unknown, but when the conditions were good it "ought to have been seen had it been as bright as when observed at Geneva and at Greenwich." At Greenwich a dusky ring was seen partly surrounding the bright rings in Oct. and Nov., 1908. The author's only observation in Oct. was on Oct. 6, and is annotated "Seeing fair," "Moisture on object-glass." A fact noted during his observations (between July, 1908, and Jan., 1909) was the unusual brightness of the crape ring, accounted for by the ring being seen very obliquely. Another fact was the change in relative brightness between the inner and the outer bright rings. When the rings are widely opened the inner ring is decidedly brighter than the outer, but the present observations seem to show that when the rings are seen at a low angle the outer ring appears the brighter of the two. This peculiarity can be explained by supposing that there are fewer particles, area for area, in the outer than in the inner bright ring. These two facts are mentioned by the author as almost proving in themselves the meteoric constitution of the rings of Saturn. With reference to the light spots or condensations on the dark side of the rings at their disappearance in 1907, the author remarks that he is quite satisfied that the inner spots were due to sunlight sifting through, and being reflected from, the particles of the crape ring. The outer spots, he believes, were due in some manner to the transmission of sunlight through the Cassini division. That the condensations were not due to thicker places on the rings he considers emphatically proved by his observations both in 1907, July and Oct., and 1908, Jan., when the rings were edge-on to the earth. At these times the condensations should have been most conspicuous if due to greater thickness, whereas in reality they disappeared. No trace of the condensations was seen when the bright side of the rings was presented at a low angle. A. E.

1509. *Notes on Stellar Aberration.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 408–414, March, 1909.)—Various items of a discussion as to whether in correcting for aberration the relative velocity of earth and planet or star is to be used or merely that of the earth alone. **H. C. Plummer.** (Ibid. pp. 414–417, March, and pp. 496–508, April, 1909.)—Plummer investigates the question from the physical aspect, using the undulatory theory. An elementary explanation is given of aberration *in vacuo*, with an extension to the theory of Airy's water telescope, and the formation of an image by a mirror. The theory of aberration with mirror image is then reconciled with Veltmann's theorem, and a proof of the latter is given at some length. **A. S. Eddington.** (Ibid. pp. 571–578, May, 1909.)—Referring to Turner's suggestion that the sun's motion in space gives rise to an aberration effect which is usually neglected, Eddington points out that this effect is constant, and for many purposes the displaced star-places may be used. If the solar motion were to change, changes of this aberration would result which would then have to be considered, and there will be a distinction in the results produced by *acceleration* of the solar motion and by its *general* velocity. Is this a possible explanation of the two star-streams? Consider, in a universe in which the true motions of the stars are everywhere haphazard, the two groups of stars which are respectively (1) very near to the sun, (2) very distant from it. For the former the displacement effect, proportional to the parallax, will be great in proportion to the aberration effect. This group of stars will thus appear to form a drift, whose motion relative to the sun would be parallel to and opposite to the true solar displacement. On the other hand, for the very distant stars the displacement effect will be vanishingly small, and assuming the aberration effect to be sensible, these stars will form a drift parallel to the direction of the solar acceleration. The author does not consider this explanation conclusive, and describes a graphic method of eliminating aberration effect from a series of selected proper motions, after which there still remain indications of the two drifts. C. P. B.

1510. *Erroneous Results of a Stereoscopic Combination of Photographs of a Comet.* **E. E. Barnard.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 624–626, June, 1909.)—The author has succeeded in obtaining a number of photographs of a comet in which the motion of an hour or so between the exposures permits stereoscopic effect. Three stereograms of dates Oct. 15, Nov. 16, and Nov. 18, 1908, were presented to the Royal Astronomical Society with the paper. Few bright comets remain above the horizon long enough for the purpose, but comet *c* 1908 (Morehouse) was visible nearly all night. These stereoscopic combinations, it is said, show the comet in beautiful relief suspended alone in space, and render its filmy breath-like character as no single picture can. The effect of reality is so great that the author cautions the beholder against the temptation to make deductions which are probably entirely erroneous. When masses are receding from the comet and rapidly changing their forms a pseudo-stereoscopic effect will be produced, and what is really the nearer portion of the comet may appear to be a distant part. In the case of some of the features where the details are not changing rapidly a true stereoscopic effect will doubtless occur. In one instance when trouble was experienced in combining two pictures for a spectrogram, which were separated by too great an interval, the difficulty was overcome by reducing the scale of the images. All the pictures were made with the 10-in. Bruce lens at Yerkes, with durations of exposure from 1 to 2 hours. The author never needs a stereoscope to combine these pictures, being able by a certain control of his eyes to obtain a far more beautiful result without the instrument. The magnification of the image is less. While a good deal of the perspective in a stereogram of any one comet may be untrue, there is no other method that can show us how a comet really looks in space, and the author believes that much can be learned of the general structure of comets from their stereographic study. A. E.

1511. *Molecular Scattering and Atmospheric Absorption.* **A. Schuster.** (Nature, 81. pp. 97–98, July 22, 1909.)—While our knowledge of the number of molecules in a gas enables us to calculate with sufficient accuracy the amount of direct sunlight which is diverted by scattering, Abbot's series of measurements at Washington and Mount Wilson provides the actual observed opacity of the air for radiation of different wave-length. Rayleigh showed that, on the hypothesis of the elastic solid theory of light, small particles of matter, acting simply by adding inertia to the ether, scatter light and retard the passage of a wave passing over them. From another view, he also showed that the same relations could be deduced from the electromagnetic theory if the particles locally affect the inductive capacity of the medium. Taking this equation the calculated values of transmitted light on the basis of molecular scattering are compared with the actual figures obtained by Abbot. The close agreement between them shows that on a clear day at Mount Wilson (altitude 6,000 ft.) atmospheric absorption is almost accounted for by molecular scattering. C. P. B.

1512. *Variations of Encke's Comet and Sun-spots.* **J. Bosler.** (Comptes Rendus, 148. pp. 1738–1741, June 28, 1909.)—The short period of this comet (3 years 3 months) renders it particularly appropriate to examine for any variation of brightness of successive returns, and this has been done to ascertain if such variations had any relation to the sun's activity as indicated by the sun-spots. The successive apparitions of the comet since 1820 are discussed, and from the curves plotted there would seem to be a close connection with the solar spot period of 11 years. C. P. B.

1513. *Stationary Meteoric Radiants.* **W. H. Pickering.** (Astrophys. Journ. 29. pp. 365–380, June, 1909.)—Since the first announcement of the phenomenon of stationary radiants by Denning in 1878 there has been no satisfactory explanation put forward. The chief facts are : (*a*) the radiants are stationary ; (*b*) the showers are of several months' duration ; (*c*) the velocity of the meteors changes noticeably in different portions of the earth's orbit. The author concludes that such meteors can only be revolving in orbits but slightly inclined to the ecliptic, and with a direct revolution. In the 278 different radiants of Denning's latest catalogue there are only two of which the motion has been definitely established—the Perseids and the Lyrids ; the inclinations of the orbits of the comets usually associated with these swarms are 114° and 80° respectively. The author then gives a geometrical analysis of the conditions following on certain cosmical groupings, and draws attention to the suggestive coincidence that the greatest number of meteors are encountered by the earth when it is passing those longitudes where the perihelia of the Jupiter family of comets are most thickly congregated. C. P. B.

1514. *Systematic Motions of the Stars.* II. **F. W. Dyson.** (Roy. Soc. Edinburgh, Proc. 29. pp. 376–392, 1908–1909.)—In a previous paper [Abstract No. 901 (1908)], Kapteyn's hypothesis, that the stars are moving in two streams, was examined, and the directions of the streams were found, with results agreeing fairly well with Kapteyn's and Eddington's. The results gave reason to believe that it would be possible in most cases to say to which stream individual stars of large proper motion belonged, and in the present paper this question is investigated. The stars dealt with are those moving more than 20″ a century. To begin with, to show the method pursued, a table is given of stars only with proper motion exceeding 100″ a century, showing for each star the magnitude, spectrum type, position, proper motion, divergence of the proper motion from the direction of either stream, and distance of the star from the two vertices of the streams. The positions assumed for the two vertices, A and B, to which the streams are directed, are (A) R.A. 90°, Dec. −10° and (B) R.A. 255°, Dec. −60°. Numerous short tables follow, for stars of various proper motions exceeding 20″, showing the numbers of stars, at several different distances from the vertex of either star-stream, which diverge 0–10°, 10–20°, &c., from the directions of the two streams. As a result, the 1,924 stars examined are provisionally divided as follows: 1,023 to Stream I., 574 to Stream II., 110 to neither (divergence over 60°), 217 doubtful. On revision many doubtful cases are decided. Kapteyn and Eddington, using stars of large and small proper motions, found an equal number in either stream, but the discrepancy may be explained by supposing Stream I. to have the larger stream-velocity, when a greater proportion of stars belonging to Stream I. will naturally be obtained by including only stars of large proper motion. An attempt to calculate roughly the relative velocities of the two streams gives a result of 3 : 2. The ratio found by Eddington using stars of all proper motions was 3 or 4 : 1. As the value of the method here employed depends on the uniformity with which the stars are distributed, the question whether the distribution of magnitude of proper motion varies with the distances from the vertices in the two streams is investigated, with result tending to confirm the assumed uniformity. The arrangement of stars according to their type of spectrum shows that, generally speaking, the two streams consist of the same kind of stars, such differences as are found not being very striking. The proportion of stars belonging to Stream I. is larger for Type I. stars, but this may be accidental, as there are few stars. If it holds generally it will partly explain the smaller ratio 3 : 2 found for the stream velocities as compared with Eddington's 3 : 1. The stars of Type I. belonging to either stream are tabulated. They diverge less from the general drift of the streams than the other stars, the very bright stars Sirius, β Centauri, &c., diverging most of the Type I. The directions of the 110 stars which do not fall within 60° of either of the two stream directions were examined, but no evidence was found of a third stream. The proper motions of the stars classified as belonging to Streams I. and II. were treated by Airy's method of determining the solar apex, and the following positions were found for the points A and B towards which the two streams are directed: (A) R.A. 93°, Dec. −7°; (B) R.A. 246°, Dec. −64°. With these positions, and relative velocities of the streams in the ratio 8 : 2, the apparent motion in two streams may be resolved into a motion of the solar system with velocity 1·65 towards a point R.A. 288°, Dec. + 44° ; and a motion of two streams to and from the point R.A. 268°, Dec. —21°, with relative velocity 4·04. Beljawsky (Astronom. Nachr., No. 4291), using similar material, determines the above points according to Schwarzschild's ellipsoidal hypothesis of the distribution of proper motions [Abstract No. 574 (1908)], and finds for the solar apex R.A. 281°, Dec. + 36° ; and for the vertex of the star streams R.A. 266°, Dec. —24°. The two-stream hypothesis of Kapteyn and Eddington agrees with the ellipsoidal hypothesis of Schwarzschild, both when applied to the stars in Groombridge's catalogue, and to the stars of large proper motion, and it is hardly possible to say which hypothesis accords the more closely with facts. A. E.

REFERENCES.

1515. *Laterally-loaded Struts and Tie-rods.* **A. Morley.** (Phil. Mag. 15. pp. 711–720, June, 1908.)—Deals with simple cases of uniformly-distributed and single-concentrated loads and simple conditions of end support.

1516. *Strength of Columns.* **W. E. Lilly.** (Engineering, 88. pp. 1–2, July 2, 1909.)—It is pointed out that if the analysis on which Euler's formula is based is correctly interpreted, it leads to the Rankine-Gordon formula ; and thus if Euler's formula is rational, so is the Rankine-Gordon formula. The analysis has been referred to in Abstract No. 1896 (1908). F. R.

1517. *Graphical Method for Latitude and Azimuth Computation.* **H. W. Fisk.** (Terrestrial Magnetism, 14. pp. 77–80, June, 1909. Paper read before the Amer. Assoc. for Advancement of Science, Baltimore, Dec. 29, 1908.)—A set of curves are drawn to facilitate the computation of latitude and azimuth observations on Polaris. It is assumed that the computer has access to tables of right ascension and declination for finding the star's hour angle. The method has been designed for those conditions of observation where it is preferable to compute the values of latitude and azimuth directly, rather than to employ tables computed for various latitudes, months, years, and hour-angles. C. P. B.

1518. *Stereoscopic Method of Investigating Photographs of the Heavens, and its Application to the Determination of the Relative Real Motions of the Stars.* **S. K. Kostinskij.** (Acad. Sci. St. Pétersbourg, Bull. 17. pp. 1259–1272, Dec. 1, 1908.)—The author describes the use of the "stereo-comparator" devised by Pulfrich [see Abstract No. 2094 (1901)] and applies it to the measurement of the real motions of three stars in the adjacent aggregates χ and *h* Persei. T. H. P.

1519. *Percentage of Inactive Gases in the Atmosphere: a Correction.* **W. Ramsay.** (Roy. Soc., Proc. Ser. A. 80. p. 599, June 20, 1908.)—The total weights of krypton and xenon previously given [Abstract No. 15 (1904)] are 10 times too small. For helium and neon all the percentages formerly stated [Abstract No. 1545 (1905)] are 100 times too small. L. H. W.

1520. *Spectroscopic Binaries in Boss's Stream in Taurus.* **E. B. Frost.** (Astrophys. Journ. 29. pp. 237–239, April, 1909.)—During a systematic investigation of the radial velocities of the stars composing the moving cluster in Taurus described by L. Boss [Astronom. Journ. 29. p. 31, 1908] it was found that the proportion of spectroscopic binaries was more than one-third. The spectra are chiefly of the first type. C. P. B.

LIGHT.

1521. *Simple Interferometer for showing the Zeeman-effect.* **A. H. Pfund.** (Phys. Rev. 28. pp. 446–449, June, 1909.)—This instrument consists of a plane-parallel plate of glass partially silvered on both surfaces, and with both surfaces protected by glass plates cemented on with Canada balsam. The whole is mounted in a heavy wooden block in which holes are cut to allow the ingress and egress of the light. The efficiency depends largely upon the thickness of the silver films, the method of determining this and of the final polishing being given in detail. E. C. C. B.

1522. *Polarimeter for Use with Opaque Bodies.* **W. F. Barrett.** (Roy. Dublin Soc., Proc. 12. 19. pp. 198–201, July, 1909.)—An instrument is described which measures the angle of max. polarisation of light reflected from the opaque surface. By means of a rack-work and simple link motion, the collimator, which renders the incident rays parallel, and the telescope, containing the analysing nicol, are simultaneously moved through equal angles. The instrument is adapted for use with liquids and also for testing with the different colours of the spectrum. G. E. A.

1523. *A New Refractometer.* **J. Lewkowitsch.** (Soc. Chem. Ind., Journ. 28. pp. 773–775; Discussion, p. 775, July 31, 1909.)—A description of an instrument by Hans Heele, Berlin; the refractometer is based on the Kohlrausch-Abbe method of determining the angle at which the limiting ray, entering the experimental body at grazing incidence emerges from a cylinder quadrant made of flint glass of high refracting power. The instrument is similar in appearance to the Pulfrich refractometer except that the cylinder quadrant replaces the rectangular prism of the latter; it is applicable to solids, liquids, and gases, and gives, in general, sharper readings than the Pulfrich. D. H. J.

1524. *Dispersion of Light in Sodium Vapour at 885° C.* **S. Loria.** (Acad. Sci. Cracovie, Bull. 6. pp. 39–60, June, 1909.)—In view of the want of agreement between quantitative results and those demanded by theory, the dispersion of non-luminous, saturated vapour is measured within the visible spectrum at known temperatures and densities. The method employed, which was that suggested by Puccianti and first used by Geisler [Abstract No. 813 (1909)], included the use of a Michelson interferometer. The sodium vapour was contained in a quartz tube on which a wire was coiled for heating purposes. Dispersion measurements were made in the region lying between $\lambda 6{\cdot}145 \times 10^{-5}$ and $5{\cdot}898 \times 10^{-5}$, and the values of the refractivity $(\nu - 1)$ obtained; this quantity is also calculated from dispersion formulæ, and the two series are in good agreement over the whole region investigated. It is also found that the unit of volume of saturated sodium vapour contains more dispersion electrons with the period of the D_2 line than those with the period of the D_1 line, the ratio of the numbers of the two kinds of electrons being 1·8. Finally it is pointed out that although experiment has been shown to agree with the characteristic equations of Drude's theory, this cannot serve as a proof of the superiority of the latter theory over those of Lorentz and Planck. G. E. A.

1525. *Amount of Light scattered from Rough Surfaces.* **W. F. Barrett.** (Roy. Dublin Soc., Proc. 12. 18. pp. 190–197, July, 1909.)—Two methods are described for comparing the amount of light scattered from a large surface, such as the wall of a building, with that from a standard source. One consists in balancing the reflected light against that from the standard by means of a rotating sector used in conjunction with a transmission photometer. In the second method the light is reflected upwards through a tube of absorbing liquid, and the amounts of light scattered from various large surfaces can be compared by the relative depths of liquid required to produce extinction. The depth which produces complete extinction measures the intrinsic brightness of the source, and that required to produce illegibility of a test-type image measures the illuminating power. Values found, taking the silvered mirror as 100, were: Plane glass, 65; ground glass or white card, 48; grey card, 35; dark grey card, 21; smooth black paper, 20; black cotton cloth, 16; dull black woollen cloth, 5. G. E. A.

1526. *Focal Length of a Converging Lens.* **I. G. Priest.** (Bureau of Standards, Bull. 5. pp. 483–497, May, 1909.)—Describes a new method of determining the focal length of a converging lens by measuring the linear diam. of a circular fringe in the real image formed by the lens. The method makes use of the system of concentric circular fringes obtained by the interference of the light reflected from a partial silver film with that reflected from a heavy polished silver film parallel to the first and behind it, the light being normal to the mirrors. The theory of the method is discussed, and results in a simple working formula, from which the focal length of the lens under test can be easily obtained for any given wave-length. Possible sources of error and the precision of the method are dealt with at some length, and it is shown that a single careful measurement will give the focal length correct to 0·5 per cent., and that a comparatively short series is sufficient to establish the value with a probable error of about ± 0·02 per cent. [See also Abstract No. 228 (1907).] A. W.

1527. *Defining Power of Objectives.* **J. de Graaff Hunter.** (Roy. Soc., Proc. Ser. A. 82. pp. 307–314, June 30, 1909.)—Description of apparatus devised at the National Physical Laboratory for obtaining a numerical estimate of the quality of definition of the image given by any optical system. An arrangement for producing a half-dark, half-bright light source is placed at the focus of a collimating lens, so as to give parallel rays. The apparatus for producing the division of light and dark field takes the form of two wheels with sector teeth at their peripheries; these being relatively adjustable the degree of flicker produced by their rotation can be controlled. The image of the illuminated edge is formed by the lens to be tested, and then viewed by a microscope with a fine slit in the focal plane of its eyepiece. The means for automatically adjusting the sector wheels is described in detail, and the method of employment of apparatus in conjunction with the Beck testing bench. C. P. B.

1528. *Distortion of Images Photographed through Glass.* **F. Schlesinger.** (Allegheny Observatory, Publications, Vol. 1. No. 14. Nature, 80. p. 503, June 24, 1909. Abstract.)—For purposes of detecting changes in star-places it has been customary for some time past at the Harvard College Observatory to expose certain stellar photographic plates with the film away from the object-glass, so that the light from the star had first to pass through the glass plate before being impressed on the film. By a rigorous examination of such plates the author concludes that no serious error due to distortion of the glass is introduced, and such plates can therefore be used for charting purposes.

C. P. B.

1529. *Selective Reflection of Monochromatic Light by Mercury Vapour.* **R. W. Wood.** (Phil. Mag. 18. pp. 187–198, July, 1909. Phys. Zeitschr. 10. pp. 425–429, July 1, 1909.)—Some experiments undertaken with the view of finding out whether any metallic reflection occurs from a mercury-vapour surface. The metal was contained in very stout-walled fused quartz bulbs which were heated to the desired temperature. There is a strong absorption line at λ = 2536·7, and the first experiments were carried out with light of this wave-length obtained from a mercury lamp. It was found that metallic reflection does occur, and that it increases rapidly with the pressure and temperature of the vapour. Further experiments were carried out with light from an iron arc, which possesses a strong group of lines at or about λ = 2536. It was then found that the light most strongly reflected is λ = 2535·67, and that λ = 2537 was not reflected until the pressure of the Hg vapour was at 10 to 25 atmos. Further, it was found that the ray λ = 2535·67 is not absorbed at all by the Hg vapour.

E. C. C. B.

1530. *Relation between Electric Birefraction of Mixed Liquids and Optical Birefraction of their Solid Constituents.* **J. Chaudier.** (Comptes Rendus, 149. pp. 202–204, July 19, 1909.)—The author's results show that electric dichroism, like magnetic dichroism, diminishes with the optical birefraction of the solid constituent. For the mixtures examined the max. electric birefraction is sensibly proportional to the optical birefraction of the solid constituents, and becomes inappreciable if the optical birefraction is less than 0·01. As, for one and the same liquid, the electric and magnetic birefractions are measured by the same number, the magnetic birefraction also obeys the above law of proportionality. [Compare Meslin, Abstract No. 1086 (1909).]

T. H. P.

1531. *Action of Light on Chromated Gelatine.* **H. Mayer.** (Zeitschr. Phys. Chem. 66. 1. pp. 33–70, March 23, 1909. From Sitzungsber. d. Kgl. Böhm. Gesell. d. Wissenschaften, Prag.)—Light reduces the electrical conductivity by several per cent. under normal exposures. The conductivity of the chromated gelatine rises rapidly with increase of temperature; not to an equal extent in darkness and when exposed to light. With sensitive chromated gelatine the conductivity varies greatly with the amount of moisture in the air. The percentage alteration of the conductivity under the action of light does not depend upon the original absolute value of the conductivity. The effect of light upon the electrical conductivity of chromated gelatine diminishes with the age of the plate, at first rapidly, then more slowly. There is a continuing action upon the electrical conductivity for some time after the impact of light has ceased.

A. D.

1532. *Electrochemistry of Light.* VII. *Theory of Solarisation.* Part I. **W. D. Bancroft.** (Journ. Phys. Chem. 13. pp. 449–468, June, 1909.)—The author discusses further the question of solarisation [see Abstracts Nos. 488, 1084 (1909)] and gives a list of conclusions in regard to photographic reversals arrived at by various investigators. He then gives his own theory of solarisation, which is based on the following two assumptions concerning the behaviour of the silver halides: (1) The action of light on a silver halide corresponds with that of a direct current or of a fairly weak reducing agent, and causes the silver halide to pass through all the possible stages. (2) A fairly strong reducing agent (a developer) does not cause the silver halide to pass through all the possible stages, and does reduce certain silver-halogen solid solutions or subhalides faster than others which contain less halogen. The effect of a depolariser in the film during the exposure is discussed.

T. H. P.

1533. *Magnetic Dichroism of the Rare Earths.* **G. Meslin.** (Comptes Rendus, 148. pp. 1598–1599, June 14, 1909.)—It has been shown by Urbain [Abstract No. 144 (1909)] that neighbouring elements of the rare earth group are clearly differentiated by their magnetic properties, although the solubilities of their salts and their atomic weights are almost identical. The author finds that salts of lanthanum, samarium, gadolinium and dysprosium exhibit direct magnetic dichroism, that is, the sign of the magnetic dichroism is the same as that of $n_s - n_l$, where n_s and n_l are the indices of solid and liquid respectively. The extreme metals, lanthanum (atomic weight, 138) and dysprosium (atomic weight, 162) exhibit a much more energetic magnetic dichroism than samarium (atomic weight, 150) and gadolinium (atomic weight, 157), the last being inactive with most liquids. Further, lanthanum and samarium do not exhibit the spontaneous dichroism shown by gadolinium and dysprosium.

T. H. P.

1534. *Magnetic Rotation in Iron Kathode Films.* **L. R. Ingersoll.** (Phil. Mag. 18. pp. 74–102, July, 1909.)—The purpose of the work described in this paper was the study of certain problems in the magneto-optics of the magnetic metals, viz., the Faraday- and Kerr-effects for a long range of spectrum; the thickness of the surface layer which gives rise to the Kerr rotation; and the relation between the Kerr rotation and the optical density of the surrounding medium. The working substance chosen was iron, since it gives the largest effects, but experiments will be undertaken later, using cobalt and nickel films. The author's bolometric method of measurement has previously been described [Abstract No. 515 (1906)] but a compensation method was used to overcome the difficulty arising from small and unavoidable changes of brilliancy of the source of light used, which would appear as spurious rotations. A large double-image prism was used as analyser, and was placed so that each of its principal planes made angles of 45° with the original plane of polarisation. The two transmitted beams of equal intensity were carried through the spectrometer, and after dispersion were allowed to fall on the two strips of a specially constructed bolometer. Any rotation would thus diminish one beam and increase the other by an equal amount—thus doubling the effect—while any small change in brilliancy of the glower would affect each beam equally, and hence give rise to no error. Rotations of less than 0·001° could be detected, and angles somewhat larger measured with an accuracy of about 1 per cent. A range of spectrum from the D lines to $\lambda = 2{\cdot}2\,\mu$ could be used. The results for the dispersion of magnetic rotation for cases of reflection from, and transmission through, iron kathode films are tabulated and curves plotted. For the pure iron films these curves are entirely similar, and show a gradual increase of rotatory power until a wave-length $1{\cdot}5\,\mu$ is reached, where the rotation reaches a max. value over $1\frac{3}{4}$ times as great as that for the D lines. After a certain thickness is reached the reflection rotation ceases to increase further with thickness of film. A layer of iron, of thickness less than 20 $\mu\mu$, or about that of the assumed "transition layer" of optical theory, gives rise to considerably more than half of this rotation. Partially oxidised films do not show the similarity between the reflection and transmission rotation dispersion curves that pure films do. The rotation for oxidised films reaches a maximum in the early infra-red and falls off rapidly with further increase in wave-length. This change in form of the rotation curve is accompanied by a corresponding change in the transmitting or reflecting powers as a function of the wave-length. The Kerr rotation is found to be nearly proportional to the refractive index of the overlying medium, which with certain assumptions may be shown to be in accordance with Voigt's theory. In the latter part of the paper the author criticises some of Skinner and Tool's work [Abstract No. 448 (1909)]. It is pointed out that their measurements of the thickness of their films are probably, at any rate for the thicker films, considerably too small, as it is quite probable that the change of phase on reflection from glass is not the same as the change of phase on reflection from thick iron films. Ingersoll also differs from Skinner and Tool in their conclusion that in the yellow-brown or "dark" films the metal is in a different state of aggregation and not in a state of partial oxidation. Ingersoll has shown that a "metallic" film after oxidation behaves in a precisely similar manner to the "dark" film, showing the same decrease of rotation with increasing wave-length after about $\lambda = 1\ \mu$. A. W.

1535. *Theory of Doublet Spectra.* **A. Garbasso.** (N. Cimento, 17. pp. 298–299, May-June, 1909.)—According to J. Stoney the doublet spectra are due to electrons vibrating in elliptical orbits which rotate on account of perturbations. The author finds the equations of motion of the electrons in two atoms, one in each, the atoms being a constant distance apart. The solutions of the equations show that the path of each electron is an ellipse, having definite perturbations. This is in accordance with Stoney's theory. S. G. S.

1536. *Elliptic Polarisation produced by a Plate of Quartz Cut in a Direction Oblique to the Optic Axis, with a Method of determining the Error of a Plate supposed to be Perpendicular to the Axis.* **J. Walker.** (Phil. Mag. 18. pp. 195–207, July, 1909.)—This is a mathematical paper, and is in the main unsuitable for abstracting. The results obtained afford a method of setting the principal section of a quartz plate perpendicular to the axis of a spectrometer, and of determining the error in the cutting of a plate that is supposed to be normal to the optic axis. The collimator is furnished with a web, placed by the ordinary method perpendicular to the axis of the instrument; the telescope is turned to one side, and a telescope with a Savart's analyser is inserted in its place with its axis in the direction of that of the collimator, and the analyser is adjusted so that when plane-polarised light passes the fringes are parallel to the web of the collimator. This sets the plane bisecting the angle between the principal sections of the plates of the analyser perpendicular to the turning axis of the spectrometer. This adjustment being made the polariser is turned until the fringes disappear exactly in the centre of the field. The quartz plate is then placed at the centre of the table of the instrument, and by means of the telescope of the spectrometer its faces are made parallel to the turning axis, and the reading determined for which its normal is along the axis of the collimator. With the polariser adjusted as above the fringes will in general be restored when the light traverses the quartz, but a series of positions can be found for which they vanish over a narrow streak extending across the field, and if the quartz plate be turned about its normal so as to bring its optic axis perpendicular to the turning axis of the spectrometer, there will be intermediate to these, further positions at which the fringes are absent over a small area at the centre of the field. In this way the principal section of the quartz is set perpendicular to the turning axis of the instrument, and a determination of the angles of incidence for which the centres of the zones of disappearance of the fringes are at the centre of the field, will give by calculation the direction of the optic axis with respect to the faces of the quartz. A. E. G.

1537. *Variations of Calcium Spectrum.* **A. S. King.** (Astrophys. Journ. 29. pp. 381–390, June, 1909.)—In continuation of former work on the calcium spectrum [see Abstracts Nos. 1414 (1908), 60 and 447 (1909)] the author describes the changes produced when the electric furnace is operated *in vacuo*, in hydrogen and in air at atmospheric pressure. The lines H and K in the violet do not appear at temperatures much below 2,400° C., and although they are strengthened at higher temperatures, they widen very slowly within the range of the furnace temperatures. The blue line 4,227 appears to depend solely upon the quantity of calcium vapour present. C. P. B.

1538. *Magnetic Decomposition of Spectrum Lines.* **M. Tenani.** (Accad. Lincei, Atti, 18. pp. 595–601, June 5, 1909.)—Voigt's theory of the Zeeman-effect is employed to obtain an expression for the number of electrons per cm.^{3} of the luminous gas taking part in the phenomenon, in terms of the difference in frequency of the two circularly polarised components of the doublet and of the two outside components of the triplet. The author's deduction is discussed in relation to the spectra of the elements of the second column of Mendeléeff's system. S. G. S.

1539. *Zeeman-effect on the B_4 Lines of Magnesium.* **M. Tenani.** (Accad. Lincei, Atti, 18. pp. 677–683, June 20, 1909.)—The B_4 lines of magnesium exhibit an anomalous Zeeman-effect, the magnetic increase in the directions respectively normal and parallel to the field being different. W. H. Sr.

1540. *Phosphorescence of Organic Compounds at Low Temperatures.* **J. Dzierzbicki** and **J. Kowalski.** (Acad. Sci. Cracovie, Bull. 5. pp. 724–731, May, 1909.)—The authors find that the phosphorescence of substances at low temperatures is often influenced considerably by very small proportions of impurities. Thus, at the temperature of liquid air, pure ethyl alcohol exhibits a scarcely visible, violet phosphorescence; the addition of 0·1 per cent. of nitraniline causes an extremely intense yellow phosphorescence of short duration. The authors have examined a number of hydroxy-, methyl-, methoxy-, nitro-, amino-, and carboxy-derivatives of benzene in dilute solutions in ethyl alcohol, the solutions at the temperature of liquid air being exposed to a quartz mercury lamp for 15 secs. The results, which are given in detail, show that, in all cases, phosphorescence of the greatest duration and intensity is given by the para-derivatives. T. H. P.

1541. *Behaviour of Kunzite under the Action of Becquerel Rays.* **S. Meyer.** (Phys. Zeitschr. 10. pp. 483–484, July 15, 1909.)—When kunzite is placed close to radium chloride, its colour changes in a few days from violet-red to green, the mineral then resembling hiddenite; a further exposure for three months is without influence on this green colour. Hiddenite, however, does not fluoresce under the influence of Becquerel rays, whilst both ordinary and green kunzite do so. Neither the intensity nor the colour of this fluorescence of kunzite is altered by exposure of the mineral to the action of radium. Further, green kunzite becomes luminous with a salmon-red light under the influence of β-radiation in the dark; natural hiddenite, however, exhibits no fluorescence. Kunzite which has been decolourised by heating fluoresces like the original form and, under the influence of radium, assumes the green colour of hiddenite without losing its property of fluorescing. The salmon-red light produced by radium, which persists for several hours, is polarised, the direction of vibration being parallel to the length of the kunzite fibres. If a piece of the green kunzite is illuminated for 0·25–0·5 hour by means of a projection-lamp, the green colour gradually disappears and is ultimately replaced by the original violet-red. If the green kunzite is heated over a Bunsen burner or in water to 85–40° C., it exhibits salmon-red fluorescence; the colourless or violet-red form does not, however, fluoresce at this low temperature. The production of fluorescence in the green kunzite by heating may be repeated several times without either the action diminishing perceptibly or the green colour changing. T. H. P.

1542. *Polarisation of Röntgen Rays.* **J. Herweg.** (Ann. d. Physik, 29. 2. pp. 398–400, May 21, 1909. Physikal. Inst. d. Univ., Greifswald.)—Haga has shown by a photographic method that the secondary rays sent out by a carbon plate are polarised [Abstract No. 1518 (1907)], confirming the result previously obtained by Barkla. He did not detect any polarisation in the primary Röntgen rays emitted by the antikathode. The author of the present paper investigated this question again, using Haga's arrangement of apparatus. The antikathode consisted of a cone of carbon, and after thorough evacuation of the Röntgen tube distinct evidence of the polarisation of the Röntgen rays from the antikathode (outside the tube) was obtained. Two maxima of brightness and darkness were observed on the photographic film. The polarisation is by no means complete, as it is in the case of the secondary rays. As observed also by Haga, the origin of the Röntgen rays in carbon differs from that in metals. J. J. S.

1543. *Transformations of Röntgen Rays.* **C. A. Sadler.** (Phil. Mag. 18. pp. 107–132, July, 1909.)—One of the chief difficulties experienced in the investigation of Röntgen-ray phenomena has been the heterogeneity of the primary beams hitherto available, and it has frequently remained doubtful which particular constituents of the composite beam are principally concerned in producing the phenomena under investigation. It has been found that from an element of greater atomic weight than that of calcium the emitted radiation consists of scattered radiation and also of radiation which is characteristic of the radiating element, this latter being very homogeneous. In this paper a description is given of the results obtained when these homogeneous rays were used to excite tertiary radiation in different substances. The chief deductions from the experiments are as follows: (1) The characteristic Röntgen radiation from a substance is identical in character whether it is emitted as a secondary or a tertiary radiation. The radiation is homogeneous and, moreover, the absorption coefficients of the radiation by other substances are the same, and independent of the penetrating power of the exciting radiation by which these homogeneous beams are produced. (2) Using the homogeneous secondary beams emitted by the members of the group of metals Cr—Ag, excited by suitable primary beams, the emission of tertiary radiation by the earlier members of the group Cr—Ag when excited by these secondary beams is subject to the following laws: (*a*) With a given substance as radiator its characteristic radiation is only excited by those secondary beams which are more penetrating than the tertiary radiation characteristic of the substance. (*b*) When the secondary beam is only just more penetrating than the tertiary the intensity of the latter is small, but as the secondary beam becomes more penetrating a very rapid increase of the intensity of the tertiary radiation to a maximum takes place. (*c*) As the secondary beam becomes more penetrating still the intensity of the tertiary radiation decays as a linear function of the ionisation produced in a given volume of air by the secondary beam. (3) When the secondary homogeneous beams from the group of metals Cr—Ag are absorbed by thin sheets of metals from the same group a large increase in the absorption takes place when the secondary beams become more penetrating than the radiation characteristic of the absorber, this increase in the absorption being intimately connected with the emission of tertiary radiation by the absorber in these circumstances. The fraction of this increase in the absorption of the energy of the secondary beam, which is re-emitted as tertiary radiation, is not constant, but decreases as the secondary beam becomes more penetrating, slowly at first, and then more rapidly when a very penetrating secondary beam is used. J. J. S.

1544. *Primary and Secondary γ-Rays.* **A. S. Eve.** (Phil. Mag. 18. pp. 275–291, Aug., 1909.)—The author has continued his investigations on secondary radiation and the γ-rays, and reaches the following conclusions: (1) Change of hardness of the γ-rays makes little difference in the relative intensities of the incident corpuscular secondary radiation from various elements, and the intensities follow the order of the atomic weights of the radiators. (2) Change in hardness of the γ-rays makes a marked difference in the relative intensities of the emergent corpuscular secondary radiations from various elements. Such radiations do not follow the order of atomic weight. (3) Hardening of the γ-rays is readily produced by lead screens, but not by iron screens of great thickness. (4) On hardening the γ-rays the emergent radiation from carbon and Al is increased relatively to heavier substances; on softening decreased. (5) Indications are given of the soft character of the secondary γ-rays. (6) The γ-rays from UrX cause emergent radiation of such a character as shows that these rays are softer than those from RaC, and harder than the secondary γ-rays. Observations were made on the gradual changes in the character of the emergent corpuscular secondary radiation when the exciting rays were varied from a very hard to a very soft type. J. J. S.

1545. *Effect of Temperature on Ionisation.* **J. A. Crowther.** (Roy. Soc., Proc. Ser. A. 82. pp. 351–357, June 30, 1909.)—Perrin, using air, concluded that the total ionisation in a gas is independent of the temperature if the pressure is kept constant. McClung [Abstract No. 1124 (1904)] repeated these experiments with air, CO_2, and hydrogen and found that the ionisation in a gas is independent of the temperature if the density of the gas is kept constant. The ionisation produced by rays of given intensity in certain gases and vapours, *e.g.*, methyl iodide, ethyl bromide, or CCl_4 is much greater than in air or CO_2. The present investigation is made to discover: (1) If the effect of temperature on ionisation produced in these gases and vapours is the same as for air; (2) if cooling down air to a temperature near its condensation point causes any appreciable alteration in the ionisation produced in it by rays of given intensity. A full description of the experiments and a diagram of the apparatus used is given. The following conclusion is arrived at: For the ionisation produced by Röntgen rays in air at the temperature of liquid air, and in ethyl bromide and methyl iodide at various temperatures up to 184° C., in every case the amount of ionisation produced is independent of the temperature of the gas if the density of the gas remains constant; so that taken in conjunction with the experiments of McClung these experiments may be regarded as showing that between the limits −170° C. and +278° C. the ionisation produced by Röntgen rays in a given volume of air at constant density is independent of the temperature of the gas. A. E. G.

1546. *New Method of Registering the Length of the Path of α-Rays.* **B. Szilard.** (Comptes Rendus, 149. pp. 271–273, July 26, 1909.)—The following is the principle of the method adopted. A screen of sulphide of zinc is arranged at a certain angle in front of a layer of radiating matter which is placed horizontally. Under these conditions the scintillations cease at that part of the screen at which the distance between the screen and the layer of active matter is greater than the course of the α-rays studied. If a photographic plate is placed upon the sulphide screen, which latter is prepared upon some thin and very transparent glass, the scintillations impress the plate and the image shows the limit to which an effect on the screen is produced. To find the length of the path of the α-rays the length of the image on the plate is multiplied by the sine of the angle between the radiating surface and the screen. With this arrangement the limit of the α-rays from polonium is studied. It is easy to obtain in 4 days with a suitable screen an effect sufficiently clear, a layer of polonium only 5 times more active than Ur being used. The action is shown on the developed plate as a deep spot: the parts nearer the active matter are darker, the intensity of the impression diminishing very slowly up to a certain point, at which it becomes relatively weak. Experiments are carried out with different specimens of polonium, in which the exposures are varied from 3 days up to 4 months, and the inclination of the screen varied from 30° to 45°. The length of the path so measured is always nearly the same, but less by 2 mm. than the least of those measured by the ionisation method. When the photographic plate is placed in position without the screen the limit of the α-ray path is not shown. The effect produced by the phosphorescence of the sulphide of zinc is always greater than that obtained directly by the α-rays. It is also shown by experiments with RaD, RaE, and RaF that the phosphorescence of zinc sulphide due to β-rays is negligible when compared with that obtained by α-rays. A. E. G.

1547. *Ionisation produced by an α-Particle.* **H. Geiger.** (Roy. Soc., Proc. Ser. A. 82. pp. 486–495, July 31, 1909.)—Rutherford and Geiger recently determined the number, N, of α-particles expelled per sec. from 1 gm. of radium [see Abstract No. 1627 (1908)]. The value of N was found to be $18{\cdot}6 \times 10^{10}$ when the radium is in equilibrium with its three α-ray products. They also found the charge carried by an α-particle to be $9{\cdot}3 \times 10^{-10}$ electrostatic unit [see Abstract No. 1628 (1908)]. Rutherford found [Abstract No. 1881 (1905)] the number, Z, of ions produced by an α-particle to be $1{\cdot}72 \times 10^5$, but this number becomes $1{\cdot}18 \times 10^5$ if for N and e the latest values are introduced. In the present research the author deals with RaC. The simplest way to determine the number, Z, of ions produced by an α-particle would be to measure the quantity of RaC deposited on a plate, and at the same time to measure the saturation current due to the complete absorption of the whole number of α-particles expelled from the active plate. From these measurements the number Z could be at once deduced. But on account of the difficulties of obtaining complete saturation under the experimental conditions, it was found necessary to adopt an indirect method. The ionisation due to the whole number of α-particles expelled from a known quantity of RaC was measured at a low pressure, allowing only a small definite portion of the range of each α-particle to be effective. The ratio of the ionisation produced within that small portion of the range to the ionisation produced along the whole path was then determined by another experiment. The average of all the measurements is shown by a curve, from which the number of ions produced within any part of the range can be found. The numbers are given in the following table :—

	Ions per mm.
At 1 cm.	2,250
2 „	2,300
3 „	2,400
4 „	2,800
5 „	3,600
6 „	5,500
6·5 (about) cm.	7,600
7 „ „	4,000

The average number of ions produced in air by an α-particle from RaC along its whole path is $2·37 \times 10^5$. All the experimental evidence seems to show that the α-particles from the different radio-active substances are identical in mass and charge, but differ only in their initial velocity. It seems, therefore, justifiable to assume that all α-particles produce the same ionisation at the same velocity. Hence if the whole range of an α-particle in air is known, the total number of ions produced by it can be calculated from the curve for RaC. This assumption was verified for polonium. The following table gives the values calculated for the number of ions produced by the different α-particles from the radium family :—

	Range.	Total Number of Ions Produced.
	cm.	
Radium	3·50	$1·58 \times 10^5$
Emanation	4·33	$1·74 \times 10^5$
Radium A	4·83	$1·87 \times 10^5$
„ C	7·06	$2·37 \times 10^5$
„ F	3·86	$1·62 \times 10^5$

The number calculated for radium itself is in good agreement with the value obtained by Rutherford, considering that his number ($1·18 \times 10^5$) must be increased by at least 10 per cent. owing to the difficulties of obtaining saturation for an intense ionisation at atmospheric pressure. A. W.

1548. *Diffuse Reflection of the α-Particles.* **H. Geiger and E. Marsden.** (Roy. Soc., Proc. Ser. A. 82. pp. 495–500, July 31, 1909.)—It is now known that β-particles can be diffusely reflected from a surface, they being scattered inside the material to such an extent that they emerge again at the same side of the plate. It was not considered probable that α-particles, being far more penetrative, could show this phenomenon [see Abstracts Nos. 1712 (1906) and 1629 (1908)]; but the authors have now found conclusive evidence of this. The reflection is not a surface but a volume effect; but the reflection is from a relatively thin surface layer of the reflector. Of the incident α-particles about 1 in 8,000 was reflected. **A. D.**

1549. *Action of Gravity upon the Induced Activity from Radium.* **L. Wertenstein.** (Comptes Rendus, 149, pp. 268–271, July 26, 1909.)—Mme. Curie has observed that the induced activity from Ra produced in moist air behaves like a body possessing weight [Abstract No. 1829 (1907)]. The first experiments described in the present communication are carried out in order to find the nature of the activity which is separated by gravity. For this, the differences of the deposited activities on the two opposing surfaces of two horizontal plates, as function of the time elapsing from the moment in which the action of the emanation ceases, is studied. In plotting the currents as ordinates and the times as abscissæ a curve is obtained which compares well with that for a mixture of RaB and RaC. This may be interpreted easily if we admit that the fall of the particles which brings the induced activity to the lower plate requires a certain time which is long enough to allow the RaA to disappear. The second experiments are for studying the change brought about by the action of gravity; this is done by means of curves (not given in paper) which represent the value of the activity of the discs as a function of their distance. A series of discs are placed in a vessel, into which is introduced air charged with the emanation. The air is filtered through glass wool but not dried. For each experiment two curves are constructed, one which represents the activity of faces turned towards the base, in function of the distances of the discs, the other the same for faces turned upwards. The faces turned downwards, which therefore do not receive the active deposit due to gravity, always show a max. activity for distances between 1 and 1·5 cm.; the activity diminishes as the distance is further increased. The faces turned upwards have, for small distances, activities proportional to the distance and identical with those of corresponding lower faces. As the distance is increased the curves obtained are of three different types, depending on the humidity of the air, which is made to vary by introducing water mixed with H_2SO_4 in varying proportions. (*a*) In air saturated with moisture, and even in air containing water-vapour in equilibrium with a mixture of equal weights of water and H_2SO_4 the activity increases rapidly with the distance, showing no indication of a maximum for distances less than 5 cm. (*b*) For vapour tensions corresponding to a mixture of equal volumes of water and H_2SO_4 the curve seems to indicate a tendency towards a limit. (*c*) By concentrating the acid up to 60 per cent. by volume a limit of activity is reached at a distance of the discs about 8 cm. It may be supposed that the induced activity diffuses at once towards the plates and towards the agglomerations formed probably by the condensation of water-vapour which entrain it in their fall. When the distance between the plates is such that a particle which falls the whole distance between the plates loses its activity during its fall, the activity of the face turned upwards ceases to increase with the distance. This limiting distance will naturally depend upon the sizes of the particles formed, and it is not impossible that these increase in proportion as the air becomes more moist. When the limiting distances for faces turned upwards and downwards are known it is possible to calculate the velocity with which the particles fall, and then by Stokes' law to obtain their diameters. From figures given it is seen that the particles ought in certain cases to reach ultramicroscopic dimensions, and this is in agreement with the visibility of the fogs obtained by the use of concentrated arc-lights. Further experiments are in progress. A. E. G.

1550. *Liberation of Radium Emanation.* **H. Herchfinkel.** (Comptes Rendus, 149. pp. 275–278, July 26, 1909.)—The emanation of Ra is only liberated in a very small degree at ordinary temperatures from the solid salts containing it, while, on the other hand, a large proportion of that of Ac is immediately set free under similar conditions. This difference may in part be due to the emanations themselves, but also in part to the physical state of the substances accompanying the radio-active element containing the emanation; thus Ra is accompanied by barium, while Ac is generally found with the rare earths. In order to ascertain whether the latter influence is of importance, experiments are carried out with the hydrates of Di, Fe, Th, Al, and Ur; fluorides of Di and Ba; oxalates of Di and Ba; sulphates of Ba and Pb; and chromates of Ba and Fe, the following method being adopted: The solution in the state of a nitrate of one of the preceding elements is mixed with 5 c.cm. of a solution which contains 0·38 mgm. $RaBr_2$ of activity nearly 40,000; the emanation set free by this quantity in 20 hours is measured; the amount liberated by the insoluble part when dried and powdered is also ascertained. Tables are given from which it is concluded (*a*) that the hydrates of Fe and Ur hold almost all the emanation, while those of Th, Di, and Al keep very little; (*b*) all these hydrates liberate a large proportion of the emanation in the dry state; (*c*) the liberation in the case of salts of Ba is very feeble and does not depend, as a rule, on the nature of the radical; (*d*) the $DiFl_3$ and the chromate of Fe liberate a much greater proportion of the emanation. The oxalate of Di sets free less of it, while the sulphates of Pb and Ba only give off a very small proportion. It appears that the amount of moisture in the air plays an important part. It is also established for several of the preparations that the quantity of emanation increases when the temperature is raised, but this elevation of temperature appears often to produce a modification of the preparation, which when it is heated for some time is no longer able to easily liberate the emanation. The results obtained have also the practical interest that by employing the precipitate from the hydrate or chromate of Fe, the hydrate of Ur, or the fluoride of Di one can obtain a strong liberation of emanation, the salt meanwhile being in the dry state.

A. E. G.

1551. *New Method of Separation of Uranium X: Relative Activity of that Substance.* **B. Szilard.** (Comptes Rendus, 149. pp. 113–115, July 12, 1909.)—The following is the method now recommended: Dissolve 50 gm. of acetate of uranium in a litre of lukewarm distilled water, then add a solution composed of iron acetate, ammonium acetate and acetic acid. The liquid is heated and kept at boiling-point for some minutes; the filtration is then quickly carried out while hot. The precipitate is carefully washed with hot water and then with a solution of carbonate of ammonia. The precipitate is then dissolved in HCl and shaken up with a large quantity of ether free from alcohol; the ether dissolves the greater part of the iron present, while the greater part of the UrX always remains in the water. In taking into account the traces of Ur in the precipitates it is found as the mean value of two series of experiments that the ionisation current produced by the UrX in radio-active equilibrium with 1 gm. of Ur is equal to that produced by 0·287 gm. of Ur in radio-active equilibrium. If it is assumed that the number of atoms decomposed per gm. of Ur per sec. is about the two-millionth part of the number for Ra, then 1 gm. of Ur in radio-active equilibrium contains about 2×10^{-11} gm. of UrX. UrX in the pure state will therefore be 10^{10} times more active than Ur in radio-active equilibrium. A. E. G.

1552. *Ratio between Uranium and Radium in the Radio-active Minerals.* **Mlle. E. Gleditsch.** (Comptes Rendus, 149. pp. 267–268, July 26, 1909.)—A preliminary account of these experiments has already been given [Abstract No. 1282 (1909)]. From the results obtained it appears that in the radio-active minerals there is no constant ratio between the amounts of Ur and Ra present. Each mineral seems to give a particular value to that ratio, *e.g.*, in autunite from France $Ra/Ur = 2·85 \times 10^{-7}$, in pitchblende from Joachimsthal $Ra/Ur = 3·5 \times 10^{-7}$, while in thorianite from Ceylon $Ra/Ur = 4·19 \times 10^{-7}$. Although these numbers are not exactly alike they are of the same order of magnitude, and we may therefore consider that a relationship between Ra and Ur does actually exist; that Ra is a disintegration product from Ur but that the mechanism of the transformation is not so simple as is now generally admitted; or that the ratio between the two elements in the radio-active minerals may under certain influences undergo changes. The first results obtained lead one to think that the ratio is so much the greater as the mineral is of older origin, and this is explained by the fact that the formation of Ra from Ur is a much slower process than we imagine it to be. There might be, for example, some intermediate products the lives of which are long with respect to that of Ur. In the second place, is the velocity of transformation independent of external circumstances? In particular, may it not depend upon the presence of certain elements in the mineral, *e.g.*, Th and Ac? These questions cannot be answered until the ratio Ra/Ur for a large number of minerals is accurately known. An important consequence of these experiments is that the determination of the mean life of Ur based upon the existence of a constant ratio between Ur and Ra in the minerals cannot be considered as exact. A. E. G.

1553. *Rate of Helium Production from the Complete Series of Uranium Products.* **R. J. Strutt.** (Nature, 81. p. 158, Aug. 5, 1909.)—A knowledge of this constant is essential to the estimation of the ages of minerals from their helium content. A solution of pitchblende is made which contains 115 gm. of Ur_3O_8, and this solution yields in 61 days a quantity of helium which, when measured in the capillary of a McLeod gauge, is found to be 2×10^{-6} c.cm. This gives the rate of formation as $10·4 \times 10^{-8}$ c.cm. per gm. of Ur_3O_8 per annum. No stress can be laid on the close agreement with Rutherford's estimate ($9·18 \times 10^{-8}$ c.cm.) in view of the very small gas volume measured. The experiment proves, however, that that estimate is of the right order of magnitude. Experiments on a larger scale are in progress. A. E. G.

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1554. *Limit of Absorption of certain Glasses in the Ultra-violet.* **H. Zickendraht.** (Zeitschr. wiss. Phot. 67. pp. 290–296, July, 1909.)—A spectrographic measurement of the limits of absorption of some specimens of glass for the ultra-violet, which is of some importance from the oculist's point of view. E. C. C. B.

1555. *Reflection of Light at Naturally Active Bodies.* **K. Försterling.** (Ann. d. Physik, 29. 4. pp. 809–832, July 6, 1909. Extract of Dissertation, Göttingen.)—Occupied chiefly with the mathematical theory (based on Maxwell's equations) of the reflection of light at naturally active bodies, either uniaxal or isotropic. The paper concludes with experiments which confirm the theory. E. H. B.

1556. *Lenses.* **Tscherning.** (Comptes Rendus, 149. pp. 108–110, July 12, 1909.)—Discusses the defects of ordinary telescope and photographic lenses, special attention being paid to astigmatism, curvature of the field, and distortion. A. W.

1557. *Dispersion Theory of Spectrum Series.* **C. Schaefer.** (Ann. d. Physik, 29. 4. pp. 715–722, July 6, 1909. Physikal. Inst. d. Univ., Breslau, April, 1909.)—In this paper the author obtains mathematically a dispersion formula which gives a finite index of refraction for all cases where the resonance period of the medium is not equal to the period of the incident vibration, but gives an infinitely large refractive index when the two periods are the same. A. W.

1558. *Spark Spectra of Chromium and Calcium.* **F. L. Cooper.** (Astrophys. Journ. 29. pp. 329–350, June, 1909.)—Wave-lengths of the lines in spectra of chromium and calcium spark, from λ2200–6700, with comparisons of their relative intensities in the corresponding arc spectra. C. P. B.

1559. *Arc Spectra of Cerium and Thorium.* **F. L. Cooper.** (Astrophys. Journ. 29. pp. 350–364, June, 1909.)—Wave-lengths of arc lines in the spectrum of cerium from λ2651 to λ4646, and in the spectrum of thorium from λ3503 to λ4535. C. P. B.

1560. *Absorption Spectra of the Nitrates in Relation to the Ionic Theory.* **E. C. C. Baly, K. A. Burke,** and **E. G. Marsden.** (Chem. Soc., Journ. 95. pp. 1096–1105, June, 1909.)—The authors have examined the absorption spectra and the electrical conductivity of hydrogen, lithium, ammonium, and silver nitrates dissolved in alcohol and in water and in various mixtures of these solvents. The results support the theory of hydrated ions. D. H. J.

1561. *Comparison Prisms for Spectrophotometers.* **L. Bell.** (Astrophys. Journ. 29. pp. 305–307, May, 1909.)—Description of a device to eliminate the black band passing through spectra due to the edge of the usual comparison prism. An ordinay rectangular prism is half silvered, and the fine silver edge used as demarcating line. C. P. B.

1562. *Analysis of the Oxides of Nitrogen by Means of their Absorption Spectra.* **E. Warburg** and **G. Leithäuser.** (Ann. d. Physik, 28. 2. pp. 313–325, Feb. 4, 1909. Communication from the Physikal.-techn. Reichsanstalt.)—The full paper corresponding to Abstract No. 603 (1908).

1563. *Influence of their State in Solution on the Absorption Spectra of Dissolved Dyes.* **S. E. Sheppard.** (Roy. Soc., Proc. Ser. A. 82. pp. 256–270, May 26, 1909.)

1564. *Expulsion of Radio-active Material during Radium Transformations.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 10. p. 422, June 15, 1909. Chem. Inst. d. Univ., Berlin.)—A note on the work of Makower and Russ [Abstract No. 1058 (1909)] relative to papers previously published by the authors dealing with this subject [see Abstracts Nos. 474 and 649 (1909)]. A. E. G.

HEAT.

1565. *Absorption of Carbon Dioxide by Charcoal.* **A. E. M. Geddes.** (Ann. d. Physik, 29. 4. pp. 797–808, July 6, 1909. The University, Aberdeen, May 21, 1909.)—The author describes experiments carried out at 14°, 81°, and 85° C. with the view of discovering the law of absorption of CO_2 by charcoal, and of ascertaining if the absorbed gas is evolved when the pressure is lowered. The measurements were made at pressures varying from 12 to 715 mm. At all three temperatures the absorption is only partially reversible, a certain amount of the gas being retained by the charcoal when the pressure is lowered. The law of absorption is found to be of the form $y = ax^n$, where y is the number of c.cm. of gas absorbed by 1 c.cm. of charcoal, x the pressure in cm. of mercury, a a constant determined by the point at which the curve cuts the y-axis, and n is the tangent of the inclination of the straight line plotted on logarithmic squared paper. The values obtained for n are: at 14°, 0·498; at 81°, 0·570; and at 85°, 0·588; and those for a are: at 14°, 1·356; at 81°, 0·740; and at 85°, 0·629. T. H. P.

1566. *Temperature of the Oxy-Hydrogen Flame.* **E. Bauer.** (Comptes Rendus, 148. pp. 1756–1757, June 28, 1909.)—In continuation of his work [see Abstracts Nos. 494, 1066 (1909)] the author has measured the temperature of the oxy-hydrogen flame. As might be expected, owing to the presence of water-vapour, at high temperature the flame possesses considerable emissive and absorptive powers for the residual rays of fluorspar. The application of Planck's formula gives for the temperature of the flame 2,240° C. The method by reversal of the sodium line gives numbers varying between 2,200° and 2,300°, according to the proportion of oxygen. This agreement is as good as that obtained in the case of coal gas. W. C.-S. P.

1567. *Distribution of Energy in the Spectrum of the Tungsten Filament.* **R. E. Nyswander.** (Phys. Rev. 28. pp. 438–445, June, 1909.)—The distribution of energy in the spectrum of the tungsten filament for various temperatures was determined by means of a reflecting spectrometer and radiometer. Assuming Wien's law $E = c_1\lambda^{-a}\epsilon^{-c_2/\lambda T}$ to hold for all values of the radiating constant, by Paschen's method an approximate mean value of a may be determined for any emission curve, independent of the temperature of the radiator. For the tungsten filament a value of the radiation constant $a = 6·53$ was obtained using the mean of six independent determinations. With this value of a a normal radiation curve for tungsten was constructed from Wien's law, and likewise a black-body curve was computed, the three having equal values of λ_{max} and E_{max}. The deviations of the actual tungsten curve from the normal radiator indicate the peculiarities of the tungsten filament. This deviation is prominent in the visible spectrum, where the tungsten curve shows strong selective radiation. At 0·5 μ the tungsten filament radiates less than normal, but at 1 μ it radiates like a black body of the same value of λ_{max}. In the regions 1·3 μ and 1·5 μ to 3 μ tungsten shows less than normal radiation; beyond 3 μ it radiates more than the normal radiator, and at 4·6 μ and 5 μ the value of a is nearly equal to that of a black body. On a curve there is shown the luminous efficiency of a complete radiator for varying values of λ_{max} and corresponding absolute temperatures. The luminous efficiencies of three tungsten curves are 1·5, 1·4, and 2·0 per cent. respectively, while the radiant efficiencies of a black body for corresponding values of λ_{max} are approximately 1·08, 1·28, 1·65 per cent. The efficiency of the normal radiation curve for tungsten is only 0·85 per cent. For this value of λ_{max} the selective radiation of the tungsten filament in the visible spectrum is more than 1·6 times normal. J. J. S.

1568. *Noble Gases and the Equation of State.* **G. Rudorf.** (Ann. d. Physik, 29. 4. pp. 751–779, July 6, 1909.)—From observations published by various investigators on the vapour pressures and isothermals of the rare gases the author concludes that the simple form of van der Waals' equation agrees with the observations as well as does the extended equation given by Happel [see Abstract No. 828 (1904)]. The observations are not, however, sufficiently accurate to allow of a decision being made between the two equations. Calculation shows that certain of the observations considered must be regarded as inaccurate; this is the case, for example, with the density of liquid xenon and with the critical constants of neon derived from the isothermals. The boiling-point of neon is calculated to be about 48° abs. The heats of evaporation of the rare gases are calculated from (1) the boiling-points, (2) the vapour-pressure curves, and (3) the surface tensions, the results agreeing moderately well. T. H. P.

1569. *Characteristic Equation of a Gas.* **A. Leduc.** (Comptes Rendus, 148. pp. 1670–1673, June 21, 1909.)—The ordinary formulæ connecting the pressure, volume, and temperature of a gas are known to be imperfect. The formula of van der Waals, for instance, leads to an error of 50 to 100 per cent. when applied to sulphurous anhydride. The author uses the following formula of the Clausius type:—

$$[P + F(T)/\phi(v)][v - h] = kT \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where h and k are two numerical constants. If p_r denote the internal pressure, that is, the coefficient of ∂v in the expression of the internal work.

$$p_r = T\partial P/\partial T - P = [F(T) - TF'(T)]/\phi(v),$$

which may be written—

$$p_r = [F(T) - TF'(T)]/v^2,$$

and v^2 may be written for $\phi(v)$ in (1). Deductions from these formulæ are discussed and experimental results given to show the accuracy that can be obtained by their use. A. R.

1570. *The Porous Plug Experiment.* **W. A. D. Rudge.** (Phil. Mag. 18. pp. 159–168, July, 1909.)—The author has made some determinations of the Joule-Thomson effect, using liquid CO_2. The plug consisted of a small brass vessel having a gas-tight cap at the lower end and at the upper end a stuffing-box through which passed a hard-steel screw used for perforating the glass bulb containing the liquid CO_2. The gas thus liberated passed out of the plug by a long, thin brass tube connected to the bottom of the brass vessel and wound round it. The apparatus was placed in a calorimeter containing water, so that the heat absorbed could be measured. Then if H = heat absorbed from the calorimeter, M = mass of gas allowed to escape, L = latent heat, K = temperature-change due to passage of gas through the plug, and S = specific heat, we have K = (H − ML)/MS. A spiral of manganin wire was placed in the bottom of the calorimeter so that any suitable temperature could be reached and maintained by an electric current. A thermometer placed in the escaping gas recorded the same temperature as one placed in the calorimeter. Radiation losses were corrected for. The water equivalent of the calorimeter and its contents was determined by passing a known current through the manganin coil and measuring the change in the temperature thereby produced. The mean result of several experiments gives the cooling effect as 1·894° C. per atmo. difference of pressure at a temperature of about 21° C. Experiments were then conducted when the gas was heated to a temperature above its critical point. The fall in temperature due to the escape of gas was estimated by plotting two time-temperature curves, (1) when the calorimeter containing the bulb was heated and the gas not allowed to escape, (2) when the gas escaped during the heating. An attempt was also made to conduct the experiment so that the temperature remained constant during the escape of the gas, regulating the flow of gas so that the temperature was constantly at 84° C. In this case the amount of heat absorbed was found from the rate of rise of the temperature just before and just after the evolution of gas. The results obtained by this last method were higher than the previous ones, and varied owing to the fact that the flow of the gas was not free, there being considerable variations in pressure. **W. C. S. P.**

REFERENCES.

1571. *Noble Gases.* **H. Happel.** (Phys. Zeitschr. 10. pp. 484–495, July 15, 1909.)—The author discusses, under the following heads, the theoretical considerations and practical investigations made concerning the mechanical and thermal properties of the rare gases: (1) Internal friction, heat conductivity and diffusion; (2) isotherms, behaviour as regards the law of corresponding states, equation of state for monatomic substances, liquefaction of helium, barotropic states and coexistence of two gaseous phases. **T. H. P.**

1572. *The Laws of Radiation and their Correct Application.* **C. Féry.** (Annal. Chim. Phys. 17. pp. 267–289, June, 1909.)—A complete account of work carried out by the author and others [see Abstracts Nos. 861, 862, 1070, 1071, and 1251 (1909)]. **W. C. S. P.**

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1573. *Motion of Electrons in Solids.* **Part II. J. H. Jeans.** (Phil. Mag. 18. pp. 209–226, July, 1909.)—The investigation of radiation of great wave-lengths [see Abstract No. 1268 (1909)] is here extended to radiation of all wave-lengths. It is first shown that the irregular motion of the electrons can be resolved into regular trains of waves, but that only those travelling with the velocity of light contribute to the radiation, all others annihilating each other by interference. The formula previously obtained for the total emission per unit volume in the time t is shown to be a special case of the general formula, and it is pointed out that the latter might have been obtained from the former by the principle of relativity. The formula for long waves is identical with the one obtained by J. J. Thomson [Abstract No. 1545 (1907)]. The analysis shows that in a perfectly reflecting enclosure the radiation will, in the steady state, be distributed amongst the different wave-lengths according to the law of equipartition, and formulæ are obtained for the rate of progress towards this state, and for the "time of relaxation." Enclosures formed of existing matter being incapable of retaining short-wave radiation, it is assumed that the partition is then such that the energy of frequency p has Θ_p times its equipartition value, and it is shown by analysis of the electron motions that, for small values of Θp, $_p=1$, and Θ_p decreases according to an exponential law as p increases, results which are in accordance with experiment. The former result had been obtained by Lorentz on the assumptions of undisturbed free-paths and instantaneous collisions [see Abstract No. 245 (1908)]. The dynamical reason of this result for small values of p now becomes evident. For the waves which contribute to the radiation will both emit and absorb radiation of frequencies equal to their own, resulting in rapid interchange of energy between the waves of electrons and radiation of the same frequency in the ether. When the wave-lengths are great compared with the distance between adjacent electrons, the whole collection of electrons can be treated as a continuous medium, the degrees of freedom of the electrons being supposed to be the waves in this medium, and these are in energy-equilibrium both with the matter and with the waves in the ether. There cannot be waves of the medium corresponding to all values of p as the latter increases, since a finite number of electrons cannot possess an infinite number of degrees of freedom. There will therefore be a transference of energy between different degrees of freedom, leading, as before shown, to equipartition if all ether vibrations are retained indefinitely, but otherwise there must be a falling-off from equipartition values. The rate of adjustment to equipartition is shown by the formulæ obtained to be the same for great wave-lengths as the rate of adjustment of electric charges to the equalisation of potential. In the case of shorter wave-lengths the adjustment will be slower, but if the ether is already filled with an adequate number of pulses and short waves, the rate will still be comparable with its value for long waves. If, however, this condition is not at first satisfied, the progress towards equipartition will take place much more slowly, the creation of pulses and short waves having been shown in the previous paper to be a very slow one. It is partly on account of this, and partly on account of the large absorption of short-wave radiation by all known substances, that natural radiation from a hot body, or from an enclosure with the most perfectly reflecting walls obtainable, is found experimentally to be almost entirely free from waves of the shortest lengths. The dependence of Θ_p on p would, unless further limited, vary with the structure of the matter concerned. This is, however, experimentally inadmissible, since the radiation in a cavity is found to be independent of the nature of the matter forming its walls. Moreover, T and p must only enter into Θ_p in the form of a ratio, in order that Stefan's and Wien's laws may hold. Θ_p must therefore be a function only of T/p and of constants which are the same for all kinds of matter. According to thermodynamical theory Θ_p must be of this form, but this, if applicable at all, can only apply to radiation in an enclosure impervious to all radiation. The author shows that, according to the electron theory, these conditions will be satisfied if, and only if, the radiation proceeds from electrons describing orbits about centres repelling as the inverse cube of the distance, these centres being of equal strength in all kinds of matter, and that the influence of forces varying as other powers of the distance, and of the presence of centres of force other than those primarily involved, must be looked for in departures from the laws of Stefan and Wien. For it is found by calculation that, if E^2 denote at any instant the mean of the squares of the electric intensities at the points occupied by the electrons, the mean square of the force (ρ^2E^2) acting on an electron must vary as T^2, and it can be shown that E^2 will not vary exactly as any power of T, and must, moreover, involve the distances, varying for different kinds of matter, between the different centres of force, if the electrons are acted on by more than one centre of force. Now it is known that there are terms in the law of force varying as the inverse square, and the electrons must always be acted on by more than one centre of force. The analysis, if sound, therefore leads of necessity to the conclusion that the laws of Stefan and Wien are only approximations. It is pointed out that J. J. Thomson, in the paper previously referred to, comes to the conclusion that these laws point to collisions with particles which have to be similar for all matter, and repel according to the law of the inverse cube. The author suggests that these similar centres of force may be found to be the positive electrons, but observes that "the ultimate test of any such conjecture must, however, be the calculation of the radiation function and comparison with experiment." G. W. DE T.

1674. *New Kind of Glow from Palladium in Vacuum Tubes.* **H. V. Gill.** (Roy. Soc., Proc. Ser. A. 82. pp. 464–476, July 26, 1909.)—A tube is fitted up containing an ebonite plug through which two stout brass leads are passed. To the ends of these leads a piece of palladium-foil is attached by means of screws. This foil is about 1 in. long and $\frac{1}{16}$ in. wide. The leads and plugs are fixed in position with sealing-wax, and the tube is exhausted by a mercury pump. The Pd is heated to the temperature required by passing an electric current through it. The pressure is reduced to 0·15 mm., and a current sent through the Pd to expel some of the gases which it contains. It is kept at a dull red heat for some time and then raised to an almost white heat, when a purple glow is seen around the hot Pd. This glow resembles the negative glow in a vacuum tube, but there is no electric field except that due to the current from the two storage cells used to heat the metal. The experiments described are made with the object of investigating the nature and cause of the luminosity. A diagram showing the most satisfactory form of tube is given. The colour of the glow is a rich purple-blue; when the foil is very hot it appears bluer, due to light reflected from the walls of the tube. There is a dark space between the glow and Pd, which is well marked when the foil is at a high temperature. The luminosity does not extend to the walls of the tube. The glow disappears when the current is stopped, and begins again when it is sent through. As Pd melts at a comparatively low temperature, Pt-foil into which palladium-black has been well rubbed is used instead, and the results so obtained are almost equally good. When clean Pd is used the glow is better than when the metal is not carefully cleaned. Platinum and carbon filaments are tested, but fail to give the glow. The glow is not affected by electric or magnetic fields, but the application of heat to the walls of the tubes causes the glow to quickly disappear; on the other hand, if the bulb is kept cool it continues indefinitely. The dark space around the Pd appears to be a temperature effect. The phenomenon occurs within wide initial pressure limits—*e.g.*, it has been observed between 0·2 and 0·008 mm. The presence of gases in the tube which have been produced from the Pd is necessary for the glow to take place. The only method of restoring the property to Pd which has been heated for some time is to leave it exposed to air for a considerable period. The disintegration of the metal has an important connection with the luminosity. Either the particles of metal are themselves the cause of the luminosity, or they carry with them something which acts on the gases in the tube. The glow is obtained when mercury vapour and phosphorus vapour are carefully excluded from the tube; the presence of water vapour is, however, necessary. When the spectrum is viewed through a spectrometer of low dispersion, it consists of a continuous portion extending from the red (λ6220) towards the blue end. Just at the extremity of this region there is a blue-green band, which can only be observed when the glow is very bright and the dispersion of the spectrometer low. Then there comes a dark space (λ4697), and after that a blue band (λ4419–λ4348). When photographed it is possible, by examining the negative with a magnifying glass, to distinguish several bright lines in the blue band which correspond to lines in the CO spectrum. Palladium charged with hydrogen has the property of causing oxygen to combine with CO in the presence of water vapour to form CO_2. This would appear to be the reaction involved in the production of the luminosity. It has not been investigated whether the luminosity is directly connected with the ionisation of gases by incandescent metals; many of the facts suggest some connection with the phenomenon of ionisation, and it seems probable that the presence of the ions from the hot Pd in the gas may be an important factor in the reactions which give rise to the luminosity.

A. E. G.

1575. *Atmospheric Electrical Observations over the Atlantic Ocean and in Porto Rico.* **K. W. F. Kohlrausch.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 25–69, Jan., 1909. From the II. physikal. Inst. d. k.k. Univ., Wien.)—(1) Measurements of the conductivity of the atmosphere were made on the way out to Porto Rico. Particulars are given of 104 measurements made between Aug. 9 and 20, 1907. No diurnal period and no connection with other meteorological elements can be traced. Proximity to land also shows no influence on the results. (2) Similar measurements were continued at Utuado in Porto Rico. 578 values were obtained during the months Oct., 1907, to Jan., 1908. The conductivity shows a diurnal variation with a principal maximum at 8 a.m. and a secondary maximum at noon. Minima occurred at 8 a.m. and 7 p.m. (3) Observations were made at Utuado of the charge brought down by rain. 141 observations showed no charge and 96 a charge too small to be measured. Of the remaining 214 observations, 111 showed a positive charge, 99 a negative one. R. G. K. L.

1576. *Atmospheric Electrical Observations near Alpine Lakes.* **E. v. Schweidler.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 91–98, Jan., 1909. From the II. physikal. Inst. d. k.k. Univ., Wien.)—The experiments are in continuation of similar ones of previous years [Abstracts Nos. 1091 (1906) and 690 (1907)]. (1) Measurements of dissipation at St. Gilgen (Abersee), made in the summer of 1907, gave results different from those obtained in previous years near other lakes. The afternoon maximum was replaced by a minimum, and the highest values were obtained in the morning and after sunset. The quotient q has a mean value 1·22; the exposure—on a balcony—was not entirely shielded from the earth field. (2) In 1908 (July 16th to Oct. 7th) observations were continued at Seeham (Mattsee), in Salzburg. The diurnal variation showed maxima at 9 a.m., 8 p.m., and at night, and minima about sunrise, during forenoon, and about sunset. The mean value of q was 1·38 for the early experiments made on the front of the balcony fully exposed to the earth's field, and 1·09 for the lake one, made in a more sheltered position. The results for both sets of experiments are summarised in tables.

R. G. K. L.

DISCHARGE AND OSCILLATIONS.

1577. *Influence Phenomena produced by the Ions emitted from a Flame placed in an Electric Field.* **A. Bernini.** (N. Cimento, 17. pp. 300–307, May–June, 1909.)—The author arranges, some distance apart, two insulated vertical metallic discs, the first A connected with an electroscope E having the complex capacity $6{\cdot}8 \times 10^{-6}$ mfd., and the other B with a second electroscope much less sensitive than the first. By means of a Thomson hydroelectric machine B is charged to a potential which is fairly high, but not sufficiently high to influence appreciably the electroscope in connection with the other disc. Between the two discs and near to B an insulated candle is now placed and lighted, the flame reaching to about the height of the centres of the discs. It is then found that, even when the distance between A and B is such that the intervening field is non-uniform, the time elapsing before the electroscope E begins to become charged is far less than would be expected from the known velocities of the ions of flames. If, when the electroscope E has reached a certain potential, the candle is removed and B at the same time earthed, the electroscope E at once begins to discharge with decreasing velocity, and ultimately remains charged at a potential much lower than the original one. If A has at first a charge of opposite sign to that of B, when the flame is interposed, the leaves of E begin to fall, to rise again nearly to their original position if the candle is removed and B earthed. These phenomena the author explains by assuming an influence effect of the charges of the ions of only one sign which issue from the flame towards A, these ions then remaining, after the annulment of B's field, for some time heaped up between the flame and the disc A. This hypothesis is confirmed by further experiment. T. H. P.

1578. *The Charge of Gas Ions.* **J. Franck** and **W. Westphal.** (Deutsch. Phys. Gesell., Verh. 11. 13. pp. 276–280, July 15, 1909. Physikal.

Inst. d. Univ., Berlin, July 2, 1909.)—In an earlier communication the authors found by measurements of the diffusion and motion of ions generated by Röntgen rays that a small proportion of the positive ions carry double atomic charges while the negative ions always carry single charges [Abstract No. 874 (1909)]. In the present experiments, which are carried out with α-rays, β-rays, γ-rays, and the point discharge, the following results are obtained: With α-rays and β-rays only ions carrying single charges are generated; with γ-rays, while no actual proof of the existence of doubly-charged ions is obtained, it is not possible to maintain with certainty that such ions are not present; with the point discharge there are generated in addition to ordinary ions carrying single charges, both positive and negative ions of the so-called "slow-moving" kind. A. E. G.

1579. *Dependence of Photo-Electric Current on Light Intensity.* **F. K. Richtmyer.** (Phys. Rev. 29. pp. 71–80, July, 1909.)—It is usually assumed that the rate of discharge of negative electrons from the surface of a metal under the action of light is directly proportional to the intensity of the incident light. Still, the available data on the subject seem rather contradictory; thus Elster and Geitel (1893), working with cells made of potassium, obtained data to prove that the two quantities are directly proportional for small ranges of light intensity. Lenard (1902) worked with a much greater range of intensities and arrived at the same conclusion, but his data when plotted do not give an absolutely straight line; on the contrary, Griffith, working with ultra-violet light and a zinc plate, concluded that the ratio of the current to the light intensity is not constant, but increases with increasing illumination, and he gave reasons why this increase in ratio ought to be expected [see Abstract No. 1678 (1907)]. Experiments, which are described in detail in the present paper, show that the photo-electric current from a sodium surface at zero potential, under the action of light from an incandescent lamp, is strictly proportional to the light intensity for ranges of intensities from 0·007 candle-ft. to 0·5 candle-ft. A. E. G.

1580. *Influence of the State of Polarisation of the Exciting Light on Electron Emission.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 10. pp. 457–465, July 15, 1909.)—The authors have previously carried out researches on the connection between the strength of the photo-electric current and the position of the plane of vibration of the exciting light with regard to the surface on which the radiation falls. They have again taken up the investigation of the dependence of the photo-electric effect on the position of the plane of vibration of a linearly polarised exciting beam, with special consideration of the question how the quantity and velocity of the emitted electrons are determined by the position of the plane of vibration with regard to the plane of incidence. As the surface sensitive to light the liquid Na-K alloy was made use of. The principal conclusions to which their investigation has led the authors are as follows: (1) Light polarised perpendicularly to the plane of incidence causes the emission from an alkali metal surface of more negative electrons than light polarised parallel to that plane. (2) The max. velocities of the electrons are in both positions of the planes of polarisation of the exciting light about equal. (3) The number of the electrons with a velocity under the maximum is (with reference to equal total numbers) greater if the exciting light is polarised perpendicularly to the plane of incidence than if the plane of polarisation is parallel to that plane. J. J. S.

1581. *Ionisation of Electrolytic Oxygen.* **R. T. Lattey.** (Phil. Mag. 18. pp. 26–31, July, 1909.)—Electrolytic oxygen from KOH and H_2SO_4 solutions contains charged mist-nuclei, bearing charges in the latter case of about 5×10^{-10}, in the ratio of about four positive to each one negative (Townsend). The author, using KOH solution, and deducing the charge E on a particle from the change of velocity produced by a known field, finds the positively and the negatively charged groups of particles are each subdivided into sets of particles carrying charges of differing magnitude, but not themselves differing in size. The charges E make $E \times 10^{10} = 4{\cdot}66$, $9{\cdot}33$, and $18{\cdot}66$. Rutherford and Geiger give the charge on an α-particle as $9{\cdot}3 \times 10^{-10} =$ two atomic charges. $Ne = 1{\cdot}23 \times 10^{-10}$ (Rutherford) where $N =$ the number of molecules in 1 c.cm. of gas; as also on electrolysis 1 c.cm. of hydrogen requires $2{\cdot}44 \times 10^{-10}$ E.S. units of current, whence $Ne = 1{\cdot}22 \times 10^{-10}$; but $e = 4{\cdot}66 \times 10^{-10}$; whence $N = 2{\cdot}62 \times 10^{19}$ [compare Planck, $2{\cdot}61 \times 10^{19}$, theory of heat radiation, Wied. Ann. [4] iv. 1901, p. 564; and Perrin $3{\cdot}0 \times 10^{19}$, direct observation in a colloid solution, Abstract No. 1821 (1908)].

A. D.

1582. *Kathode Volatilisation.* **F. Fischer.** (Zeitschr. Elektrochem. 15. pp. 512–514, July 15, 1909. From the Chem. Inst. d. Univ., Berlin.)—A further reply to Kohlschütter [see Abstracts Nos. 582 and 1278 (1909)], dealing particularly with the valencies assumed by Kohlschütter to arrive at equivalent masses of metals volatilised. Kohlschütter's own figures do not really conform to his valencies, and as his equivalence fails for hydrogen, the chemical theory of kathode volatilisation cannot be regarded as established.

H. B.

1583. *Passage of Electricity through Gaseous Mixtures.* **E. M. Wellisch.** (Roy. Soc., Proc. Ser. A. 82. pp. 500–517, July 31, 1909.)—On ionisation, breaking off of negative nuclei leaves positive nuclei; these charged nuclei gather several gas molecules, and the resulting molecular aggregates constitute the gaseous ions, both negative and positive. Suppose SO_2 and oxygen in admixture were ionised; the positive nuclei from the former would be larger and of greater mass than those from the latter; a difference in velocities might reasonably be expected (two distinct mobilities in an electric field). SO_2 and oxygen, ethyl ether and air showed no such result: some kind of averaging process goes on; it might be through exchange between the molecules in the ionic cluster and those in the medium (Blanc); but the explanation is entirely different. Some vapours in small traces reduce the mobilities of positive and negative ions in air; hydrogen is very little, methyl iodide very much ionised; hydrogen and methyl iodide give velocities which approximate to that which would ensue if the ionisation had been due to the hydrogen; so that the charge cannot be carried throughout by the methyl iodide molecule, and there must have been a transference of the charge from a MeI to a hydrogen molecule. This suggests that the large vapour molecules are unstable in the presence of hydrogen molecules; in that case the vapour molecules could not hold the ionic charge for any considerable period in the presence of hydrogen; but it appears that though as hydrogen is added the charge tends more and more to be carried as a hydrogen ion, the MeI molecule can accompany the charge to quite an appreciable extent even in the presence of a considerable quantity of hydrogen. Possible explanations of the transfer of charge from vapour to hydrogen are discussed; it is extremely probable that when the ions move through a mixture of two gases there is a continual interchange of charges between the two sorts of molecules, this both for the positive and the negative ions; and if we could assume the charge can exist in the free state for a certain fraction of its life we could explain the marked differences in the mobilities of the two kinds of ions in certain gases, the fraction not being the same for positive and for negative charges in a given gas. In flames the ion approximates to a single detached charge either positive or negative, the mass of the negative carrier being (Moreau) at 2,000° C. equal to $1{\cdot}1 \times 10^{-25}$ gm., intermediate between a corpuscle (10^{-27}) and a hydrogen atom (10^{-24}). Some vapours (water, alcohol, acetone) retain the charges much more firmly than others (methyl iodide). [See also Abstracts Nos. 1272, 1278 (1909).] A. D.

1584. *Volatilisation by Atom Rays.* **J. Stark.** (Zeitschr. Elektrochem. 15. pp. 509–512, July 15, 1909. Physikal. Inst. d. techn. Hochschule, Aachen, May 30, 1909.)—The author protests against Kohlschütter's statement [see Abstracts Nos. 581 and 1278 (1909)] that the mechanical energy of a canal-ray particle should, according to Stark, be increased by an increase in the mass of the atom, and explains that his (Stark's) arguments concerned the amount of kinetic energy which would, during impact, be imparted by the impinging atom ray to the struck atom. He further questions the formation, during the kathode volatilisation, of endothermic compounds between the kathode metal and the gas, and that the amounts of metals volatilised should be chemically equivalent. He proves by calculations that Kohlschütter did, on the contrary, demonstrate that different metals are, for equal current intensity and equal drop of kathode potential, not volatilised in simple multiple proportions. There may be a minimum drop of kathode potential required for effecting kathode volatilisation; but the carbon filaments in glow-lamps are slowly volatilised at potentials as low as 50 volts. The phenomena are too complex to allow of our experimentally settling the relations between amount volatilised and drop of kathode potential, and the chemical theory of kathode volatilisation has no experimental basis. H. B.

1585. *Size of Particles from the Kathode.* **L. Houllevigue.** (Annal. Chim. Phys. 17. pp. 297–318, July, 1909.)—A piece of glass exposed for 5 sec. to kathode rays will show a difference when breathed upon or exposed to the vapour of mercury. Steaming an ordinary piece of glass brings down deposit always at the same scattered points and at no others; the points of deposit indicate previous rubbing, scratching, &c., of the glass. Kathode radiations increase the number of nuclei of deposition; the same nuclei manifest themselves in a silvering bath; but this property belongs solely to projected particles of the material of the kathode, not to kathode rays proper. By comparing two exposures to kathode particles, one for a time t sufficient to produce N nuclei per mm.^{2}, the other for a time T sufficient to produce a deposit e mm. thick, we have, if v be the volume of each particle in mm.^{3}, $v = et/\mathrm{TN}$. The pressure must be maintained constant. From this $v = 4{\cdot}3$ to $7{\cdot}9 \times 10^{-13}$ mm.^{3}, whence the mass of each projected particle is about 6×10^{-13} mgm., or about 20 million molecules, or equal to cubes with sides equal to 80 $\mu\mu$, an unexpectedly large size; but the deposit can be recognised as granular, about 100 $\mu\mu$, under a 1,250 magnifying power. The result seems due to evaporation from the kathode and condensation in spots on the glass rather than to a break-off of portions of the kathode surface. A. D.

1586. *Virtual Anodes in Discharge Tubes.* **A. Righi.** (Accad. Lincei, Atti, 18. pp. 653-656, June 20, 1909.)—Further experiments confirming the existence of a virtual anode composed of aggregated positive ions resulting from the break-up of those rotating positive electron-ion couples which constitute, according to the author's hypothesis, the "magnetic rays" when the discharge takes place in a tube in a magnetic field. A. D.

1587. *The Electric Arc.* **Cheneveau.** (Rev. Électrique, 12. pp. 63–68, July 30, 1909. Paper read at the Clermont-Ferrand meeting of the Assoc. franç. pour l'avancement des Sciences.)—In order to explain the phenomena of the arc, the supposition is sometimes made that it is caused by a series of successive discharges, and can become also the source of electric oscillations. In order to test this hypothesis the author has made an experimental study of the arc by means of a rotating mirror and photographic plates. Any disturbance of the arc which lasted longer than the 200,000th part of a second could be readily detected. The results arrived at are as follows: (1) A stable direct-current arc exhibits no discontinuity. (2) The apparent discontinuities in the whistling arc are due to whirling movements mainly in the region of the crater. The velocity of rotation is about 500 turns per sec., but it can vary between 100 and 1,200. The larger the current the greater the velocity. (3) The whistling arc, however, shows no trace of discontinuities having periods smaller than this, provided, at least, that they are greater than the 200,000th part of a second. A. R.

1588. *Constitution of the Voltaic Arc.* **A. Occhialini.** (Accad. Lincei, Atti, 18. pp. 672–677, June 20, 1909.)—The results obtained by Villard [Abstract No. 1185 (1908)] are not opposed to the theory that the electric arc is due to the movement of positive and negative ions in opposite directions, since the over-production of ions tends to diminish the value of the electric field. Both the electrodes emit electric charges. The centre of the arc consists of an equal number of positive and negative ions, but around the electrodes there is an excess of ions of opposite sign to that of the electrode. The contractibility and cohesion of the arc follow naturally from its constitution. W. H. Si.

1589. *The Labile Condition of Electric Currents.* **H. Barkhausen.** (Deutsch. Phys. Gesell., Verh. 11. 11. pp. 267–272, June 15, 1909.)—With reference to the characteristic theory of Kaufmann [Abstract No. 1672 (1900)], the labile condition with an arc lamp and a small dynamo machine was demonstrated. Certain theoretically possible equilibrium positions on the characteristic curve are "labile," *i.e.*, they are practically not established in face of the small variations of the current which take place. The conditions for this are discussed in the paper. J. J. S.

1590. *Discontinuity of Potential at the Surface of Glowing Carbon.* **J. A. Pollock, A. B. B. Ranclaud,** and **E. P. Norman.** (Phil. Mag. 18. pp. 229–233, Aug., 1909. Paper read before the Royal Soc. of New South Wales.)—Owing to the projection of ions by hot substances, a discontinuity of potential occurs at the surfaces of the electrodes in any circuit when they are heated. Richardson has calculated the value of the potential discontinuity by means of the gas theory of metallic conduction [see Abstract No. 1489 (1904)], and Duddell has found experimentally that at the surface of the kathode of the ordinary carbon arc there is a forward e.m.f. of 6·1 volts, and at the surface of the anode a back e.m.f. of 16·7 volts. In a circuit with one heated electrode in air the projection of the ions from the hot surface makes a p.d. between the electrodes when the current is zero. When both positive ions and electrons are emitted, the electric force may change sign in the neighbourhood of the heated surface owing to the difference in the distances from the electrode at which the two classes of ions are stopped by collisions with the gas molecules. Using the apparatus described in a previous paper [see Abstract No. 681 (1909)], the authors have found the p.d. for zero current for the case of glowing carbon at various temperatures. For zero current the hot carbon was positive to the cooler electrode in all cases. At 3,120° abs., with 50 volts between the electrodes, the ratio of the flow of negative electricity from the hot carbon to the flow of positive, when the p.d. is reversed, was as 20 to 1. Assuming that the work done in connection with the passing of the electrons through the surface layer may be considered as represented by their translational energy when they emerge into the gas the surface discontinuity of the potential V is given by the equation $V = mv^2/2e$, where m is the mass of the electron, e the ionic charge, and v the component, in the direction of the field, of the velocity with which the electrons are projected from the hot surface. On this assumption it is deduced from the experimental results obtained that the velocity with which electrons are projected from glowing carbon varies from $1{\cdot}5 \times 10^8$ cm. per sec. at 3,875° abs. to $2{\cdot}5 \times 10^8$ cm. per sec. at 3,698° abs. In a similar way a lower limit of 3×10^7 cm. per sec. is found for the velocity with which electrons are projected from a Nernst filament. A. R.

1591. *Action of Ultra-violet Light on the Spinterometer.* **B. Marzetti.** (N. Cimento, 17. pp. 387–391, May–June, 1909.)—It is found that the action, whether favourable or unfavourable, of ultra-violet light on the spinterometer is exercised only on the negative pole. In those cases where the action of light appears to affect, partly or solely, the positive pole, the phenomenon is due to diffusion or reflection of the light from one pole to the other.

T. H. P.

1592. *Action of Light on the Explosive Distance for Discharge in Air.* **L. Tieri.** (Accad. Lincei, Atti, 18. pp. 683–687, June 20, 1909.)—An account of experiments, illustrated by photographs, from which the author concludes that the impeding effect on the discharge produced by the action of ultra-violet light on the kathode is due to the suppression of the electric cloud around the kathode. W. H. Sı.

1593. *Discharge Potentials with Alternating Currents: Influence of the Curvature of the Electrodes.* **J. Kowalski** and **U. Rappel.** (Acad. Sci. Cracovie, Bull. 5. pp. 707–724, May, 1909.)—All experiments in which up to the present measurements have been undertaken with alternating currents have been of a technical nature, with the possible exception of those of C. Steinmetz. In the present experiments a high degree of accuracy is aimed at. The paper is divided into two parts, in the first of which the method used is described, and the results of direct measurements given. Spherical electrodes 2 cm., 3·85 cm., 10 cm., 15 cm., 20 cm., and 30 cm. in diam. respectively are used. A method is adopted by which the distance between the electrodes is gradually altered until a discharge takes place, and very concordant results are obtained. The absolute values of the tension are from 4 to 6 per cent. smaller than those which have been obtained by direct currents. The reason for this is doubtful, and the point is under consideration. Tables of the discharge potentials are given for the different-sized electrodes, for sparking distances ranging from about 0·1 to 2 cm. The temperatures and pressures under which the experiments are carried out are also given. A. Russell has put forward a theory that the discharge potential is a function of the curvature of the electrode. When calculating the max. stress from measured discharge potentials a known amount which he calls "lost volts" is deducted. For air Russell fixes this quantity as 800 volts. The formula for the field density between two spherical electrodes is next investigated, and then a series of tables giving results of calculations made with the object of testing Russell's theory. These tables show that the stress so calculated is not a constant, but appears to approach a minimum value for a certain discharge distance; and, further, it is stated that Russell's theory gives no explanation for the observed facts. A. E. G.

1594. *Electric Discharge over Mercury.* **E. L. Lederer.** (Deutsch. Phys. Gesell., Verh. 11. 11. pp. 259–261, June 15, 1909. Physikal. Inst. d. k.k. Univ., Czernowitz, May, 1909.)—In the case of a mercury spectral tube it was noticed that the discharge first set in if a knock was given to the supports of the tube or to the table. The cause of this was investigated, and the explanation appeared to be that through the sudden blow the mercury rubs against the glass walls of the tube, and that the p.d. thereby originated is sufficient to set up a discharge. Such discharges between the glass surface and the mercury suffice to ionise the gas and render possible the passage of the inductorium discharge. J. J. S.

1595. *Discharge of Electricity from Pointed Conductors.* **H. T. Barnes** and **A. N. Shaw,** with note by **J. Zeleny.** (Roy. Soc., Proc. Ser. A. 82. pp. 336–350, June 30, 1909.)—The effect of moisture on the electric discharge from points has been studied recently by Zeleny, who observed the formation of a coloured deposit on steel needle-points when viewed under the microscope [Abstracts Nos. 113 and 1465 (1908)]. The formation and nature of this deposit has been examined in detail by the authors of this paper, who find that it only occurs when there is moisture in the air through which the discharge takes place. The moisture appears to be condensed around the negative oxygen ions and swept into the metal anode-point. In completely dry air the deposit was not observed, but even a minute trace of water-vapour is sufficient to cause the formation of a deposit, though the negative oxygen ions alone are not able to cause the oxidation of the point even under a powerful electric field. The apparatus used in the experiments was similar to that employed by Zeleny. A high power of the microscope was required for observing the effects. The various growths which occur are classified under the names granular formation and tabular, or icicle, smooth, and thin-film formations. With different degrees of dryness of the air the amount of the deposit varied accordingly. CO_2 does not appear to have any influence on the formation of the deposit; but the largest deposits were obtained for every metal used with moist oxygen. As regards the influence of pressure it was found that: (1) With new and consequently very sharp points pressure increases the deposit. (2) With points not new and thus somewhat blunted increase of pressure decreases the deposit. (3) For ranges of pressure less than 1 atmo. the effect of change of pressure is of the second order, and may act in either direction according to the condition of the point. With the possible exception of Pt., in which case the formation may be platinum-black, it is probable that the deposits are the oxides of the metals. This is supported by the fact that the growth is much greater when the point is positive than when negative. Since the presence of moisture is necessary for the production of the deposits it appears probable that in comparatively dry air the negative ions possess greater aptitude for collecting water-vapour than do positive ions, just as in the case of a supersaturated atmosphere. The deposit can be produced on various metals. The following are the results obtained in various cases: (1) Al, (2) Zn, (3) Steel, (4) Cd—gave the largest deposits in order. (5) Sn, (6) Mg, (7) Ag, (8) Brass, (9) Cu—gave medium to very small deposits. (10) Pt—gave tarnish after 40 minutes' treatment. (11) Pb, (12) Ni, (13) Pd—probably no deposit, but doubtful. (14) Au—no deposit. In general the points gave a much larger quantity of deposit when they were positive electrodes than when negative. In the case both of steel and Al the distance between the points when the max. deposit was obtained was 2 cm., the average potentials in both cases being about 11,000 volts. J. J. S.

1596. *Damping in Oscillatory Circuits.* III. and IV. **M. Wien.** (Ann. d. Physik, 29. 4. pp. 679–714, July 6, 1909.)—The first two Parts were dealt with in Abstract No. 960 (1908). III. As a result of further investigations it was found that the Leyden jars were the cause of disturbing phenomena at the higher potentials, and the present work deals with the testing of substitutes for the glass condenser. The ordinary defects of the glass Leyden jar are well known, but of these it is the "brushing" which has given rise to most of the earlier errors in the determination of the spark decrement. The original should be referred to for the comparative results with Leyden jars, condensers with oil dielectric, and condensers with compressed gases as dielectric, it being only possible here to quote the author's brief summary. The compressed-gas condenser (weight 6 kg. and capacity $1{\cdot}7 \times 10^{-3}$ mfd.), is able to withstand, at 15–20 atmos. pressure, as much as 40,000 volts. Air gives about the same results as CO_2, and so CO_2 is adopted owing to the smaller risk of explosion after a possible charring of the insulating material. The energy losses, if any, must be very small. Any increase which there may be, due to such losses of the decrement, is independent of the voltage. The loss in oil-filled condensers is also very small; the increase in the decrement as compared with the compressed-air condenser is about 0·001. IV. Four of these compressed-gas condensers were used to determine the spark decrement (δ_s) at very high sparking voltages. It is found that δ_s rises, at first rapidly, and then more slowly, with increase of the voltage; thus for 20,000, 50,000, and 100,000 volts the values of δ_s found are respectively 0·05, 0·08, 0·02. These values are for sparks in air at 1 atmo. pressure, and with zinc electrodes of 22 cm. diam. With smaller electrodes (5 cm. diam. and less) the spark length and also δ_s are greater at higher voltages. For wireless telegraphy such high spark potentials are considered to offer several advantages. Laboratory experiments have shown that, as against the Leyden jar circuit with a decrement of 0·08, the current-effect at the receiver, for equal primary energy, is about trebled, while the decrement of the oscillations is halved. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1597. *Some Electrical Properties of Selenium.* **L. S. McDowell.** (Phys. Rev. 29. pp. 1–36, July, 1909.)—The recovery curves for selenium have been studied, *i.e.*, the curves which show the rate of return to the normal dark resistance after exposure to light has ceased. The dark resistance of the cell was measured, and the cell then exposed for a definite number of seconds to the light, its resistance observed when the light was shut off and at frequent intervals during the return to normal resistance. The cells used were of the Bidwell and Ruhmer types, while for the excitation the light of the arc lamp dispersed by a flint-glass prism and also light from a 16-c.p. incandescent lamp, screened by red and green glasses, were used. As current source a single storage cell was used, the resistance being measured by a Wheatstone bridge, the selenium cell forming one arm. The following are the results of the investigation: (1) The form of the recovery curve depends on the intensity of the excitation and on the wave-length of the exciting light. In general the time of recovery increases with the intensity of the excitation. Recovery is slower for excitation by infra-red light than by light of the visible spectrum. Individual cells differ in the relative time of recovery for different wave-lengths as well as in the absolute time of recovery for light of the same intensity and wave-length. (2) The effect of increased duration of excitation upon the form of the recovery curve is similar to the effect of increased intensity. (3) Excitation requires time. While from 60 per cent. to 80 per cent. of the entire increase in conductivity may be produced in the first 5 min., for complete saturation hours are required. The rate of excitation varies with the intensity and the wave-length of the exciting light. The time required for complete saturation may decrease as the intensity of the light diminishes, but the initial rate of excitation always increases with the intensity. The variation in the rate of excitation of the individual cells for the different wave-lengths corresponds to the variation in their rate of recovery, *e.g.*, those cells which show the most rapid recovery for red light show also the most rapid excitation for red light. (4) The relation between the resistance and e.m.f. is approximately a straight line relation. The resistance decreases as the e.m.f. increases. (5) Different cells show a variation in the relative sensibility to light of different wave-lengths, but no relation was found between this variation and the variation in the curves of recovery and excitation. (6) Electric oscillations affect the resistance, and hence the sensibility of the selenium cell. These effects are of two kinds, immediate and deferred. Both may be in the nature of coherer effects, and both depend upon the condition of the cell at the time when the oscillations are applied. J. J. S.

1598. *Effect of Light on the Conductivity of Nitrogen Peroxide.* **M. Tenani.** (Accad. Lincei, Atti, 18. pp. 16–18, July 4, 1909.)—The effect of the interposition of nitrogen peroxide on the rate of discharge of a charged disc by light from an electric arc has been measured for positive and negative charges. The discharge of the former is accelerated, and of the latter retarded, results which may be explained by assuming that the nitrogen peroxide absorbs light, conduction only taking place through the ions formed by the action of the absorbed light in the midst of the gas. W. H. Si.

1599. *Action of α-Rays upon Solid Dielectrics.* **T. Bialobjeski.** (Comptes Rendus, 149. pp. 120–122, July 12, 1909.)—Experiments carried out with sulphur are here described. The apparatus used consists essentially of a plane condenser, between the plates of which the substance to be studied is placed. When an electric field is acting in the presence of polonium, it is noted that the current due to the α-rays, which is very strong at first in comparison with the spontaneous current, is rapidly reduced to zero. The penetrating radiations, on the contrary, produce in sulphur a current which diminishes with extreme slowness. The total quantity of electricity received during the whole time the current passes is measured for different voltages, when plates of sulphur 1·7 mm. and 15·4 mm. in thickness respectively are used. For the thin plate, starting from 860 volts (about), the time the current lasts is strictly proportional to the voltage employed. When thin sheets of Al are placed between the sulphur and polonium the duration of the current is considerably increased. The quantity of electricity received is diminished relatively very little. It is thought that these results may lead to a new method of measuring the absorption of α-rays by matter. Langevin suggests that the α-rays of polonium penetrate into a very thin layer of the dielectric; they produce there an intense ionisation. Under the action of the field the ions of the two signs move in opposite directions. In the end it happens as if the charge from the upper plate is passed from the surface covered by the polonium on to the lower surface of the ionised layer, and the current ceases at that instant. To explain the fact that at high voltage the duration of the current is proportional to the e.m.f., it is assumed that there is then a saturation current. By calculation it is found that the ionised layer is 1·4 mm. in thickness, and the velocity of the ions in sulphur is approximately $5 \times 10^{-\text{[illegible]}}$ cm. per sec. per volt per cm. A. E. G.

1600. *Conductivity of Dielectrics under the Action of Radium Rays.* **B. Hodgson.** (Phil. Mag. 18. pp. 252–258, Aug., 1909.)—The method employed by the author in these experiments consisted in measuring the current through the dielectric, firstly without and then with the radium near, the difference between the two currents being the ionisation current. The dielectrics used were solid paraffin, vaseline, and heavy paraffin oil. The curves showing the behaviour of these dielectrics under the action of radium rays are similar to those obtained by Jaffé [Abstract No. 489 (1908)] with very pure substances. The immediate increase in current due to the radiation was also observed with benzene, toluene, aniline, and carbon disulphide. T. H. P.

1601. *Electrical Conductivity Phenomena of Powders and some Solid Substances.* **R. H. Goddard.** (Phys. Rev. 28. pp. 405–428, June, 1909. Electrician, 63. pp. 711–713, Aug. 13, 1909. Abstract.)—The author has investigated three phenomena of conduction through loose powders and a few solids: (1) Change of conductivity with time; (2) development of asymmetric conduction; (3) deviation from Ohm's law. The results are summarised as follows: (*a*) In general when an e.m.f. is applied to a powder, or to the solids AgI, BaS, and molybdenite, the conductivity falls, rapidly at first, finally approaching a limiting value. On the circuit then being broken the conductivity rises, rapidly at first, then more and more slowly. The changes were in a very few cases actually reversed. (*b*) While the changes under (*a*) were taking place the conductivity was found to be changing in the direction opposite to that in which the current originally flowed. The rates of change were only in the case of AgI, of the same magnitude. Solid molybdenite alone gives a large permanent difference of conductivity. (*c*) With all the substances examined, except powdered zinc perborate, Ohm's law is not obeyed, except under the application of great pressure (10,000 atmos.). (*d*) A vacuum has the effect of reducing the conductivity, which rises again when the air is re-admitted. The results are considered to be explained by a theory put forward depending on slow diffusion of ions in heated contacts between particles. L. H. W.

1602. *Effect of Torsion on Thermal and Electrical Conductivity.* **N. F. Smith.** (Phys. Rev. 28. pp. 429–437, June, 1909.)—In a recent paper the author described a series of experiments on the changes produced by tension in the thermal and electrical conductivities of metal bars [Abstract No. 491 (1909)]. The present paper deals with the corresponding effects produced by subjecting the bars to a twisting couple. The experimental method was the same as in the previous investigation. The bars used were round, $\frac{5}{16}$ in. in diam., and 4½ ft. long. Observations were made on two bars of soft steel, two of iron, two of copper, and one of brass. The observations on each bar were repeated four or more times on different days. In each case the results obtained from observations on different bars of the same material were substantially the same. In all cases the thermal conductivity is diminished by torsion. When the torque is removed the recovery is not complete, even though no permanent twist has been produced. The thermal conductivity tends to regain its original value after a period of rest. The change is greatest in the case of steel, where the torque applied is the greatest and where also the change in electrical conductivity is most marked. The max. change produced at any one time in the thermal conductivity of steel is from 3 to 5 per cent. The corresponding change in its electrical conductivity is from 0·1 to 0·2 per cent. The max. changes produced in the thermal conductivity of iron, copper, and brass are from 1 to 3 per cent., while the corresponding changes in their electrical conductivity are less than $\frac{1}{10}$ of 1 per cent., being less than the experimental error. It seems probable that a linear relation exists between the thermal conductivity and the angle of twist. This is seen most clearly in the curves given for copper, where the experimental points fall almost exactly on parallel straight lines. In all the experiments described the torque acted in the same direction. J. J. S.

1603. *Absolute Measurement of Resistance.* **E. B. Rosa.** (Bureau of Standards, Bull. 5. pp. 499–509, May, 1909.)—A new method is suggested for the absolute measurement of resistance. A revolving coil, or 2 such coils, are to be so disposed in the magnetic field of a pair of fixed coils as to yield an e.m.f. which can be compared, by means of a differential galvanometer, with the fall of potential through a fixed resistance, and so give the absolute value of the resistance. The advantage of this method would be that the e.m.f. generated could be a thousand times greater than in a Lorenz apparatus, while the thermoelectric forces at the sliding contacts would be considerably less; for a revolving coil cuts the lines of force four times in each revolution, and two coils of only 125 turns each would therefore generate a thousand times the e.m.f. produced by a disc, supposing the field and speed the same, and the area of the coils equal to that of the disc. The thermoelectric forces due to the brushes would be less because the commutator could be much smaller than the disc. The method of securing this result is not quite so simple as in the Lorenz experiment, but it seems to be free from any serious difficulty. An apparatus of this kind is being constructed at the Bureau of Standards, Washington. F. E. S.

1604. *Measurement of Resistance in Electrostatic Units.* **Hurmuzescu.** (Annal. Scientifiques de l'Univ. de Jassy, 6. pp. 1–7, July, 1909.)—If a condenser of capacity c and charged to a potential V is discharged through a resistance R, the quantity dQ of electricity passing in time dt may be written Vdc. The current is $dQ/dt = Vdc/dt = V/R$. Thus $1/R = dc/dt$. For a condenser consisting of 2 concentric cylinders the capacity per unit length is $1/2\log(D/d)$, where D and d are the radii of the cylinders; a relative axial displacement of the cylinders of amount dl produces a variation dc in the capacity equal to $dl/2\log(D/d)$. Hence $dc/dt = (dl/dt)/[1/2\log(D/d)] = 1/R$.

If the dimensions of the cylinders are known it remains to determine dl/dt only to find R. The author constructed a condenser consisting of 2 coaxial cylinders, the inner one being insulated and charged to a potential V, and the outer one was earth-connected and capable of slow axial motion. The medium between the cylinders may be a badly conducting solid or air subject to the action of Röntgen rays. When the latter acts on the annular space between the cylinders (the other parts being protected by lead screens) the air becomes a conductor, and a slow discharge results. By continually displacing the external cylinder the potential V can be maintained constant. For a constant resistance the current is constant, and so is the speed of displacement; dl/dt may therefore be taken as equal to the ratio of the total displacement to the total time. The resistance R can thus be determined.

F. E. S.

1605. *Self-inductance of a Ring of Small Circular Section.* **K. Terazawa.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 5. pp. 84–94, May, 1909.)—It is ordinarily assumed that the formula given by Wien for the self-inductance of a ring of small circular section is the most accurate [see Abstract No. 271 (1908)]. The author checks Wien's calculation, and finds that the formula obtained by his method is *identical* with that previously given by Rayleigh and Niven. The formula, therefore, for the self-inductance L of a ring is—

$$L = 4\pi R\left\{\left(1 + \frac{1}{8}\frac{\rho^2}{R^2}\right)\log_e \frac{8R}{\rho} + \frac{1}{24}\frac{\rho^2}{R^2} - \frac{7}{4}\right\},$$

where R is the radius of the circular axis of the tore and ρ is the radius of its cross-section. The author also checks his calculation by another method, using toroidal co-ordinates instead of polar, and again obtains Rayleigh and Niven's result. The practical difference, however, between the old formula and the amended formula is small. For example, the error is only 1 in 26,000 when $\rho = 1$ cm. and $R = 20$ cm.

A. R.

1606. *Thermoelectric Behaviour of Tantalum and Tungsten.* **W. W. Coblentz.** (Phys. Rev. 28. p. 312, April, 1909. Abstract of paper read before the Amer. Physical Soc., Feb. 27, 1909.)—Over the temperature range from −180° to +300° C. the thermoelectric power of a Cu-Ta couple (five wires) is about 4·1 microvolts per deg., which is 1/10 that of a Cu-constantan couple. In the case of tungsten-copper the inversion temperature occurs at about 40° C. The thermoelectric power is about 3·8 and 4·5 microvolts per deg. for temperatures below −100° and above +200° respectively. In both couples the direction of the current is the same as that of a Cu-constantan couple.

L. H. W.

1607. *Thermo-E.M.F. of a Tantalum-Copper Couple.* **R. L. Pearson.** (Electrician, 63. p. 594, July 23, 1909.)—Apparently unaware of Coblentz's earlier work [see preceding Abstract] the author gives an account of observations made upon a filament of tantalum taken from a lamp. One junction was immersed in paraffin oil contained in a silvered Dewar vacuum vessel, while the other was kept in the same liquid maintained at 0° C. The thermoelectric current flowed from Ta to Cu at the hot junction. The thermo-e.m.f. was not large. As the temperature of the hot junction varied from 33° to 66°—the limits of observation—the e.m.f. increased regularly from 17 to 32 microvolts, the curve connecting e.m.f. and temperature being a straight line.

J. J. S.

1608. *Thermo-elements.* **O. Knopp.** (Phys. Zeitschr. 10. pp. 439–445, July 1, 1909.)—An account is given of various researches on the behaviour of thermo-elements, including (1) the influence of the resistance of the junctions on the sensitiveness; (2) the position of various metals and alloys on different potential series; (3) the dependence of the thermo-e.m.f. of alloys on their percentage composition: under this head the alloys chiefly examined were those of Cu-Ni and Fe-Ni and others containing varying amounts of Ni; (4) the connection between the thermo-electric sensitiveness and the thickness of the wires (by making very thin wires the sensitiveness can be considerably increased); (5) the influence of the gas pressure and the temperature on the sensitiveness of a thermo-element. With increasing temperature it was found that the sensitiveness of the thermo-element decreased. J. J. S.

1609. *Sensitiveness of Thermo-elements.* **K. E. F. Schmidt.** (Phys. Zeitschr. 10. pp. 438–439, July 1, 1909.)—Working with a thermo-element formed of manganin-constantan wires whose thickness was 0·0154 mm. and length about 2 cm. the highest sensitiveness hitherto attained has been realised. Such elements render possible the measurement of currents of about 89×10^{-6} amp. with a galvanometer of moderate sensitiveness. By lessening the diam. of the wires a still further increase of sensibility has been obtained. These sensitive elements are of value in the measurement of electric oscillations. J. J. S.

1610. *New Method for determining the Potential and Internal Resistance of Galvanic Elements.* **J. M. Schmierer.** (Elektrochem. Zeitschr. 16. pp. 67–72, June, 1909.)—The author has worked out a method by means of which the potential and internal resistance of a galvanic element can be determined by means of voltmeter readings. Two readings are taken, and by means of appropriate formulæ the required quantities can be calculated. The first reading is made directly, and the second reading either after the resistance of the voltmeter has been doubled by the insertion of a resistance, or else after connecting two of the elements in series or parallel. The results are accurate to two places of decimals. Examples of the method are given. T. S. P.

1611. *Wehnelt Interrupter with Alternating Current.* **F. Piola.** (N. Cimento, 17. pp. 328–338, May–June, 1909.)—The use in a Braun tube of a magnetic field parallel to the kathodic flux renders the spot more luminous and definite, so that the photographing of the curve described by it is facilitated. Wehnelt's apparatus functions well with alternating current, and, contrary to the general opinion, equally in the two half-periods, provided a suitable arrangement is employed. When there are more variations of the current for every half-period, these are not distributed uniformly in the period itself, but become more and more concentrated towards the crest of the curve the lower the intensity. As is the case with continuous currents, there is a super-elevation of the potential at the extremities of the apparatus, and, further, the current traversing the Wehnelt apparatus is never interrupted completely by the action of the latter, so that the term "interrupter" is not strictly applicable to this apparatus. With apparatus of the Simon symmetrical type, having an aperture not quite symmetrical, liquid currents are formed indicating different modes of formation of the bubbles in the aperture. T. H. P.

1612. *Mechanism actuated by Magnetic Properties of Metals.* **A. Fodor and de Bûty.** (Comptes Rendus, 149. pp. 206–207, July 19, 1909.)—Should an iron or a copper disc be inserted the different susceptibilities of these metals will cause the disc to be rejected by the machine, which is adjusted for a coin of nickel only. L. H. W.

1613. *Bifilar Vibration Galvanometer.* **W. Duddell.** (Phil. Mag. 18. pp. 168–179, July, 1909. Paper read before the Physical Soc., May 14, 1909. Electrician, 63. pp. 620–622, July 30, 1909. Abstract.)—The moving system of the galvanometer consists of two fine bronze wires which are stretched between the poles of a strong magnet. The current passes up one wire, over a pulley, and down the other wire. The tension on the wires can be varied by means of a spring attached at the upper end. In order to limit the length of the wires free to vibrate, they pass over bridge-pieces which can be moved nearer or further apart by means of screws. A small mirror attached to the middle of the two wires enables one to measure the current. The mass of the wires being fixed, as also the moment of inertia of the mirror, the time of vibration of the wires can be varied by varying the length and tension. From a series of curves which are given it is seen that the instrument can be used over the range 90 ∿ to 1,900 ∿. The damping being very small, the resonance is sharp, and this is also shown by curves. The sensibility of the instrument was determined by putting it in series with a high non-inductive resistance across a small non-inductive resistance through which was passed a current from a small high-frequency alternator. The current through the small resistance was measured by means of an accurate dynamometer. The galvanometer is practically insensitive to anything except the fundamental of the wave-form of the alternating current, for which it is tuned; thus its reading is, strictly speaking, only comparable with that of the dynamometer for a current having a pure sine wave-form. The sensibility of the instrument, expressed in mm. of amplitude at a distance of 1 m. per R.M.S. micro-ampere, decreases very nearly inversely as the frequency for which the instrument is adjusted; whereas for direct current the sensibility decreases inversely as the square of the frequency for which the instrument is adjusted. By dividing corresponding values of the sensibility, at various frequencies, for alternating and direct current the author has obtained the "magnification" curve of the instrument, which shows how much more sensitive the instrument is to alternating current (of proper frequency) than to direct current. W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

1614. *Harmonic Analysis and Resonance.* **H. Abraham.** (Comptes Rendus, 149. pp. 204–206, July 19, 1909.)—Calls attention to the fact that some care is needed before inferring that the harmonic analysis by resonance gives Fourier components which furnish a physical representation of the primary phenomena. Thus with a Villard alternator (as used for wireless telegraphy) as primary, furnishing a sudden e.m.f. followed by a period of repose, we might have in the resonator a number of harmonics persisting during the period of arrest, and thus draw a false conclusion as to the behaviour of the primary. E. H. B.

1615. *Mechanical Stress and Magnetisation of Iron.* I. and II. **W. Brown.** (Roy. Dublin Soc., Proc. 12. No. 12. pp. 101–122, May, and

No. 17. pp. 175–189, June, 1909.)—*Part I.*—Experiments were carried out with the object of finding the effects of keeping: (1) the longitudinal magnetisation and the cross-sectional area of an iron wire constant and varying the longitudinal stress per unit area; (2) the longitudinal magnetisation and the stress per unit area constant and varying the cross-sectional area of the wire; (3) the longitudinal magnetisation and cross-sectional area of the wire constant and varying the circular magnetisation and the longitudinal stress per unit area; (4) the longitudinal magnetisation and the stress per unit area constant and varying the cross-sectional area of the wire and the circular magnetisation. An iron wire was suspended in the vertical component of the earth's magnetic field. The top end was fixed to an insulated support on a cross-beam in the ceiling of the room, and the lower end about 9 ft. below dipped into a mercury cup. On the lower end of the wire was fixed a non-magnetic cylinder of brass and lead, to which was attached two light pointers, by means of which the required twist could be given to the vertical wire. The wire could be put in circuit by means of a key with a sensitive moving coil ballistic mirror galvanometer of 825 ohms resistance. An earth-inductor was arranged to be put in circuit at intervals, to test the constant of the galvanometer. The following is a summary of the results obtained: (1) The momentary electric current produced by an axial twisting in a magnetic field of an iron wire which is fixed at the top and in a vertical position with a vibrator on its lower end is very approximately proportional to the amplitude of the oscillation of the vibrator within the elastic limit of the wire. (2) When the longitudinal magnetism and the cross-sectional area of an iron wire are kept constant the circular magnetism produced by twisting the wire is diminished as the load is increased up to the $\frac{1}{11}$th part of the tenacity of the wire. When the load is *increased* 3¼ times the circular magnetism is *decreased* about 40 per cent. (3) When the load and the longitudinal magnetism in an iron wire are kept constant the circular magnetism produced by twisting is proportional to the cross-sectional area of the wire within the elastic limit of the wire. (4) When the longitudinal magnetism is kept constant round an iron wire which is carrying an electric current of density 100 amps. per cm.^{2} the max. twist of the free end of the wire is *decreased* 16 per cent. for an *increase* of 70 per cent. in the load, and for the same change in the load the circular magnetism is decreased 9 per cent. (5) When the load is kept constant on an iron wire which carries a current of density 100 amps. per cm.^{2} the max. twist of the free end of the wire *decreases* as the longitudinal magnetism *increases*. For a load of 10^3 gm. per cm.^{2} the twist is *decreased* 23 per cent. When the magnetic field is *increased* 2·5 times, and when the load on the wire is *increased* 2·48 times, the max. twist is *decreased* 30 per cent. for the same variation of the longitudinal magnetism. (6) When the load on an iron wire is kept constant at 10^4 gm. per cm.^{2} and the longitudinal magnetism *increased* from 4 to 13·5 units, or about 3 times, the circular magnetism is *decreased* about 50 per cent., and when the load on the wire is *increased* 2·48 times the *decrease* of circular magnetism is about 60 per cent. for the same range of field variation. (7) When the load per unit area, the longitudinal magnetism, and the current density in iron wires are kept constant the max. twist of the free end of the wire *increases* with the cross-sectional area of the wire up to about $20·6 \times 10^{-3}$ sq. cm. In a magnetic field of 0·45 c.g.s. unit, when the cross-sectional area of the wire is *increased* 5¼ times, the max. twist on the wire is *increased* 9 times; and in a field of 7 c.g.s. units the max. twist is *increased* about 1⅔ times for the same change in the wire's cross-sectional area.

Part II.—The results described in the present paper were obtained with iron wires in a uniform magnetic field. In order to obtain uniform longitudinal magnetic fields stronger than the vertical component of the earth's field a long solenoid was used. The transitory electric current produced when an iron wire is twisted in a magnetic field was proved by experiment to be entirely due to the presence of the field. The various results obtained are shown in curves and tables, the chief conclusions being the following: I. When a mechanical twist is given to the wire and the transitory electric current measured (1) in an iron wire under constant longitudinal stress and magnetised longitudinally the circular magnetisation rises to a maximum in a weak magnetic field, and the value of the longitudinal magnetic field which produces max. circular magnetisation is different with different-sized wires. (2) When the longitudinal load is 10^6 gm. per sq. cm. and the cross-sectional area of the wire is *increased* about 4·7 times (*a*) the longitudinal magnetic field which produces the max. circular magnetism is *decreased* about 54 per cent.; (*b*) the max. circular magnetisation is *increased* 2·5 times; (*c*) the longitudinal magnetic field required to give the highest value of the max. transitory current is *decreased* 28 per cent.; (*d*) the highest value of the max. transitory current is *increased* 3·7 times. II. When an electric current is sent through the wire and the mechanical twist measured (1) the change in the mechanical twist lags behind the change in the circular magnetisation, a cyclic curve and hysteresis loops being obtained; (2) when an iron wire of cross-sectional area $20·6 \times 10^{-3}$ sq. cm. is placed in a uniform magnetic field of 2·5 c.g.s. units and the longitudinal stress per unit area on the wire is *increased* about 7 times, the circular magnetism is *decreased* about 80 per cent., and the max. twist of the free end of the wire is *decreased* about 14 per cent.; (3) the value of the longitudinal magnetic field which produces max. circular magnetisation is different with different-sized wires; (4) when the longitudinal load is 10^6 gm. per cm.^{2} and the cross-sectional area of the wire is *increased* about 4·7 times (*a*) the longitudinal magnetic field which produces max. circular magnetisation is *decreased* about 28 per cent.; (*b*) the max. circular magnetisation is *increased* about 8 times. J. J. S.

1616. *Magnetic Properties of Tungsten Steels.* **T. Swinden.** (Inst. Elect. Engin., Journ. 42. pp. 641–670; Discussion and Communication, pp. 671–684, June, 1909. Abstracts in Electrician 62. pp. 880–882, March 12, and Discussion, pp. 974–975, April 2, 1909. Elect. Rev. 64. pp. 587–589; Discussion, pp. 589–590, April 9, 1909.)—Investigation of the magnetic properties of eight steels with about 3 per cent. tungsten and from 0·14 to 1·07 per cent. carbon. As carbon increases, $B_{max.}$ decreases regularly and is practically the same as in corresponding carbon steels, even when the steels are in the quenched condition. The fall in $I_{max.}$ agrees fairly well with Benedicks' formula [for reference see Abstract No. 1782 (1905)], using $\frac{12}{184}$ W as the carbon equivalent of tungsten. Remanence is considerably higher than in the corresponding carbon steels, and the formula applicable is $I_{max.} H_c/\text{Rem.} = 2 + 1·8 H_c$. The coercive force of the lower carbon steels is little affected by the use of 3 per cent. tungsten. Quenching differentiates the tungsten steels from the carbon steels, even in the case of the 0·14 per cent. carbon steel. H_c is very considerably raised in the tungsten steels with higher carbon by quenching. Tempering at 400° decidedly softens the steels. H_c is reduced almost to the normal value, but still increases with carbon content as in annealed specimens. H_c has a max. value at about 0·5 to 0·6 per cent. carbon in the case of "normalised" samples (cooled in the air from 950° C.). The hysteresis losses are distinctly higher for the quenched samples than in the corresponding carbon steels. The permanence has a decisive max. value of about 600 at about 0·45 per cent. carbon in the hardened samples, although the coercive force increases regularly with carbon. Tempering lowers the permanence and obliterates the peak. The ratio of permanent to remanent intensity increases regularly with carbon (and coercive force) in the hardened steels, and is proportional to $H_c - 6·5$. Curie's results regarding effects of shocks, mild tempering, and slight demagnetising on permanence are confirmed. The magnetic properties and microstructure are correlated, and the fact is emphasised that although tempering greatly increases permeability, yet the ordinary microstructure remains unaltered, although of course the constitution within the grains must be deeply changed. In the *discussion*, **J. W. Ullett** stated that the exceptional accuracy of workmanship of Continental sparking magnetos was a more important factor in their success than the magnets, with which Sheffield-made magnets had been found to compare favourably. **C. Benedicks** considers that the tendency of the high-carbon steels to be non-magnetic when hardened is due to the presence of dissolved carbon both as martensite and austenite. F. R.

1617. *Properties of Steel at Low Temperatures.* **C. W. Waggoner.** (Phys. Rev. 28. pp. 393–404, June, 1909.)—The steels to which the following results refer were all annealed at 1,000° C. and furnace cooled before the magnetic tests. At liquid-air temperature the permeability and hysteresis loss in a 0.058 per cent. carbon steel are greater than at atmospheric temperature in high fields, but less in very low fields. The effect of the low temperature upon steels containing from 0·6 to 1·87 per cent. carbon is to increase the hysteresis loss and decrease permeability in all fields. The ratio of hysteresis coefficient (at saturation) to coercive force is constant at 0·00118 at 20° C., and constant at 0·00108 at −180°. The increase in hysteresis loss with increasing carbon has a minimum value at about 1·1 per cent. carbon and then increases. The change in hysteresis loss due to cooling is analogous to magnetic hardening by forging steel. The coefficients of expansion at liquid-air temperature appear to decrease regularly from 928×10^{-8} for carbonless iron (by extrapolation) to 850×10^{-8} with 1·85 per cent. carbon. F. R.

1618. *Magnetisation of a Cylinder in a Magnetic Field.* **W. Voigt.** (Phys. Zeitschr. 10. p. 488, July 1, 1909.)—The author gives and explains a simple and elegant theorem which he thinks has hitherto been unknown. It relates to the magnetic force which a thin cylindrical tube of weakly magnetisable material experiences in a magnetic field. The expression is; $K = \pi kbc(R_1^2 - R_0^2)$, where K is the total force which the magnetised body experiences parallel to the Z-axis, b is the radius and c the thickness of the thin-walled cylindrical tube whose susceptibility is supposed to be feeble, k being the magnetisation constant and $R^2 = Z^2 + Y^2$, R representing the total force whose components are Z parallel and Y normal to the axis of Z. The total force acting on the cylinder is, according to this, only dependent on the same fields which act on the end cross-sections (the suffixes (0) and (1) referring to the two bases of the cylinder), and therefore their direction is without influence. If the field acts parallel to the axis of the cylinder, then each end surface would experience the total force $\pm 2\pi kbcR^2$ and each member of the expression above obtains a simple meaning. J. J. S.

1619. *Variation of Mass with Magnetisation.* **M. G. Lloyd.** (Terrestrial Magnetism, 14. pp. 67–71, June, 1909.)—The experiments of L. A. Bauer have raised the question as to the possibility of magnetisation affecting the mass of the body. Bauer's observations were made on bar magnets in both magnetised and unmagnetised states and in various orientations with respect to the earth's field. It is obvious that if there be local disturbances in the field the weighings may give different results for different positions of the magnet. For the purpose of determining whether the gravitational force is constant it is desirable to have a specimen forming a closed magnetic circuit, so that there will be no action on it from the earth's field. The ring form was chosen for the tests and precautions were taken to eliminate the effects of the preliminary kick noticed on magnetisation [see Abstract No. 1299 (1908)]. Any changes arising from magnetostriction may be neglected as being smaller than the error of observation. A Ruprecht balance belonging to the Bureau of Standards was used, and although certain of its parts were not free from magnetic material it was considered this would not interfere with the experiment on a ring specimen. The ring consisted of laminated steel, with inside diam. 6·9 cm., outside 8·9 cm., and mass about 185 gm. This was wound with 180 turns of No. 20 insulated copper wire. The current for magnetisation was led in by strands of very fine silver wire of such small rigidity that the swings of the balance were not visibly modified. With magnetisations up to a flux density of 18,500 gauss no alteration in weight as much as one part in eight millions was detected. **L. A. Bauer.** (Ibid., pp. 72–76, June, 1909.)—Bauer draws attention to the important difference between the two series of experiments, in one case the magnet having free poles, while the other had no free poles and no external field. Although Lloyd's experiment is satisfactory as showing that mere magnetisation has no influence on mass, it leaves untouched the problem of the effect of a magnet under ordinary practical considerations of usage. A series of weighings by C. Walker are then given, showing variations of the weight of a straight magnet 4 in. long when weighed at different orientations. Reversal of the magnet does not necessarily eliminate the differences found. C. P. B.

1620. *Earth Currents between Stations of Different Altitude.* **B. Brunhes and P. David.** (Comptes Rendus, 149. pp. 74–76, July 5, 1909.)—In a previous paper [Abstract No. 589 (1909)] the character of the earth currents between Clermont and Puy-de-Dôme was outlined, showing the great difference of potential normally existing between the two stations and the exceptionally high value during the progress of magnetic storms. Considerable differences were found in the potential developed between pairs of stations during magnetic disturbances. Comparisons of the East-West line currents with those of same orientation at Tostosa, in Spain, show a close similarity in character, but the French values are much greater. In general the East-West currents are feeble during periods of magnetic calm. The perturbations are now classified according as they attain to the values 50 or 170 millivolts per km. C. P. B.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1621. *Sterilization of Potable Water by the Quartz Mercury-vapour Lamp.* **J. Courmont and T. Nogier.** (Comptes Rendus, 148. pp. 523–524, Feb. 22, 1909.)—Kromayer's lamp, the tube of which is made of quartz, was found to have an intense bactericidal effect in water to a distance of 0·8 m. A metal barrel of 115 litres' capacity having a diam. of 0·60 m. was constructed, and in the centre of this a Kromayer's lamp working under 9 amps. was suspended. Numerous experiments showed that at the end of 1 or 2 min. sterilization of the water is complete, even though the water is extremely polluted. H. W. P. Y.

1622. *Experimental Determination of the Efficacious Dose of Röntgen Rays retained by the Tissues.* **H. Guilleminot.** (Comptes Rendus, 148. pp. 652–655, March 8, 1909.)—By radiographic and fluoroscopic methods the author has estimated the rate of transmission of Röntgen rays through the principal tissues of the organism, and has constructed curves having for abscissæ the thickness of the tissue in mm., and for ordinates the intensities of the rays transmitted. From this a second curve may be constructed by subtraction, in which the ordinates represent the number of units of radiant energy retained by successive mm. of tissue. This he calls the curve of the rate of absorption. The rate of absorption is in direct relation with the efficacious dose. If by this means the mean coefficient of absorption of a tissue is known, it becomes possible to estimate the dosage that a tissue at a given depth will obtain from a given source of Röntgen rays, and, on the other hand, when it is required to administer a certain dose to a tissue, it becomes possible to determine the conditions, such as the degree of hardness of the tube and the amount of filtration required which would be necessary. H. W. P. Y.

REFERENCES.

1623. *Production of Rotating Fields by Damped Oscillatory Currents.* **O. M. Corbino.** (N. Cimento, 17. pp. 280–292, May–June, 1909.)—A theoretical paper in which it is shown that the results obtained by Artom with two circuits [Abstract No. 701 (1909)] are in agreement with the theory already advanced by the author [Abstract No. 874 (1904)]. Theory does not furnish data as to the constants for the circuits in order to produce the desired effect, but the most favourable conditions are deduced from general theoretical considerations. W. H. Sl.

1624. *Coefficients of Capacity and Mutual Attractions or Repulsions of Two Electrified Spherical Conductors when close together.* **A. Russell.** (Roy. Soc., Proc. Ser. A. 82. pp. 524–531, July 31, 1909.)—A purely mathematical paper. By extending a theorem first given by Schlömilch, the author obtains formulæ which enable the attractive and repulsive forces between two electrified spherical conductors to be easily calculated, however close the spheres are to one another. These formulæ, in conjunction with Kirchhoff's formulæ, give the complete practical solution of the problem. By their means Kelvin's table has been recalculated and extended. T. P. B.

1625. *Theory of Coupled Circuits.* **L. Cohen.** (Bureau of Standards, Bull. 5. pp. 511–541, May, 1909.)—The author obtains a complete solution of the problem of coupled circuits—direct-coupled circuits as well as those coupled electromagnetically—by a method which avoids the difficulty of getting the roots of a biquadratic equation. Both cases are fully worked out. The paper is altogether mathematical and cannot be abstracted. T. P. B.

1626. *Coefficient of Reflection of Electrical Waves at a Transition Point.* **L. Cohen.** (Bureau of Standards, Bull. 5. pp. 549–554, May, 1909.)—An expression for the ratios of the reflected and transmitted waves to the incoming wave at a transition point is developed in a simple manner. The paper cannot be fittingly abstracted. T. P. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1627. *Improvements in Manometers for the Measurement of Osmotic Pressure.* **H. N. Morse and B. F. Lovelace.** (Amer. Chem. Journ. 40. pp. 325–337, Oct., 1908.)—In the experiments on osmotic pressure the gas column of 400 to 500 mm. becomes reduced under the highest pressures to about 15 mm., and the correction for meniscus alone amounts to 0·3 atmos. It is therefore of the utmost importance to secure the most accurate calibration that is possible. Details are given as to the filling of the tubes, comparison of different manometers, and the determination of the corrections for (1) bore of the tube, (2) meniscus, (3) capillarity, and (4) temporary and permanent stretching of the tube. The details are likely to prove of very great value to other workers, but cannot be adequately described in an Abstract, and should be referred to in the original. T. M. L.

1628. *Genesis of Elements.* **W. Ramsay.** (Chem. Soc., Journ. 95. pp. 624–637, April, 1909. Presidential Address, 1909.)—Expounds the hypothesis that the generic difference between elements is due to their gain or loss of electrons; not of such supplementary electrons as convert an element into an ion, but of electrons more closely associated with the atom. The gain or loss of electrons causes the atom to be converted into an atom of some other element. This is already suggested by the genealogy of "polonium" from radium through radium emanation and six other intermediate stages. The influence of ultra-violet light upon bodies tends as a rule to make them part with electrons, and this may be either an exothermic or endothermic reaction. Both cases are known. There is reason to believe that change from one elemental form of matter into another would be accompanied by an unusually large gain or loss of energy, for it is known that the "degradation" of radium is coincident with the loss of a relatively enormous amount of energy, and this energy is confined to a small mass; it is highly concentrated. If such concentrated energy could be applied to ordinary elements they might be decomposed. The numbers representing the atomic weights can be represented on the hypothesis that the addition or subtraction of definite groups of electrons is the cause of their divergence from a perfectly regular series. The author has further studied the action of radium emanation on solutions of copper sulphate and nitrate, using glass vessels. They showed traces of lithium, whereas without the emanation they did not. Silver nitrate showed no corresponding result. A solution of 270 gm. of pure thorium nitrate was left in a flask for 3 years to test for the formation of He from Th. No satisfactory proof of He could be obtained, but several c.cm. of CO_2 were produced, which cannot be accounted for unless evolved from the Th. With the aid of radium emanation CO_2 was obtained from thorium nitrate, zirconium nitrate, and hydrosilicofluoric acid. Carbon is therefore most probably a degradation product of Th, Zr, and Si. Similar experiments with lead were negative in their result, and with bismuth rather doubtful.

E. E. F.

1629. *Brownian Movements Pyolographed.* **de Broglie.** (Comptes Rendus, 148. pp. 1163–1164, May 3, 1909.)—By concentrating the beam of an arc lamp upon a small portion of a gas containing some finely-divided substance, such as tobacco smoke, in suspension, it is possible to obtain photographs of Brownian trajectories with an exposure of 8 sec. and a magnification of 40 diam. The particles, to judge from their mobility, are about 5×10^{-6} cm. in diam. One of the negatives is reproduced, and shows the minute zigzag paths of the particles, but very imperfectly. [See Abstract No. 1287 (1908).]

E. E. F.

1630. *Brownian Movements.* **de Broglie.** (Comptes Rendus, 148. pp. 1815–1818, May 17, 1909.)—The photographs of Brownian movements afford a means of determining whether the particles are electrically charged, and the amount of the charge. It is only necessary to observe the effect of an electrostatic field upon the movements, when an application of Stokes' law of motion through a viscous fluid gives the charge if the diam. and the mobility are given. The diam. is derived from the displacement without a field by Einstein's formula, $a = (RT/N)(t/8\pi\mu\Delta^2)$, where a is the diam., Δ the mean displacement in time t, and μ the viscosity. For small tobacco particles $1/\Delta^2 = 0{\cdot}7 \times 10^3$ cm.^{2}, for a time $t = 8{\cdot}5$ sec. The mobility in unit field is $27{\cdot}5 \times 10^{-5}$ cm. per sec. This gives $a = 4{\cdot}9 \times 10^{-6}$ cm., and e the charge $= 4{\cdot}5 \times 10^{-10}$ electrostatic units, or the charge of one electron. Other particles have a charge equal to that of two or more electrons. An attempt was made to determine the diam. of still smaller particles by diffusion. It appeared to be only a few $\mu\mu$. But even these particles were quite visible in the ultramicroscope.

E. E. F.

1631. *Charge of Chemical Fumes.* **M. de Broglie** and **L. Brizard.** (Comptes Rendus, 148. pp. 1457–1458, June 1, 1909.)—By the method of Brownian movements [see two preceding Abstracts], it is possible to observe the behaviour of small particles of newly-formed chemical substances, such as the fumes of sal-ammoniac. These show high mobilities, due apparently to the fixation of a single [negative ?] atomic charge per particle. Exposed to radium rays, the particles become four or five times less mobile, and their charges are both positive and negative. Fumes produced without sensible heating or bubbling, like those of PCl_3, $SnCl_4$, or HCl, are uncharged, but can be charged with both signs by ionising radiations. Lively reactions give rise to charged fumes, such as those produced by projecting SO_3, Na, or PCl_5 into water, or powdered As or Sb into chlorine. Sulphur distilled in nitrogen is neutral, and the flame of burning sulphur is non-conducting.

E. E. F.

1632. *Electric Charges in Chemical Reactions.* **M. de Broglie** and **L. Brizard.** (Comptes Rendus, 148. pp. 1596–1598, June 14, 1909.)—The charges produced during violent chemical reactions are due to the mechanical rupture of solid or liquid surfaces. In cases where there is no such rupture, as in the decomposition of lead carbonate, no charges are observed. But if the haloid salts of the alkalies are decrepitated by heat the fumes are charged, also when potassium permanganate is calcined.

E. E. F.

1633. *Chemical Action of Penetrating Radium Rays upon Water.* **M. Kernbaum.** (Comptes Rendus, 149. pp. 116–117, July 12, 1909.)—In a preceding communication [Abstract No. 1319 (1909)] it was concluded that in acting through glass upon distilled water the rays formed oxygenated water (H_2O_2) and set free hydrogen. The presence of H_2O_2 in the water was then only tested qualitatively. In the present experiments by using a very dilute solution of permanganate of potash it has been found possible to ascertain the amount present to within 10 parts in 100. The evacuation of the apparatus is now carefully carried out, and no trace of free oxygen is detected. It is therefore concluded that the reaction which takes place can be represented by the equation $2H_2O = H_2O_2 + H_2$. The energy required for this is obtained from the rays given off by 0·1 gm. of nearly pure $RaCl_2$, and is calculated to be 0·016 gm.-cal. per day, in which time 4 cub. mm. of hydrogen are liberated. This means that about 1/17500 of the total heat energy given out by the Ra is thus made use of. The proportion of heat used in this manner increases with the thinness of the glass. It is probable that the effect is entirely due to the action of the β-rays, since no such effect is produced in a similar experiment when Röntgen rays are used. A. E. G.

1634. *Physical Properties of Radium Emanation.* **R. W. Gray** and **W. Ramsay.** (Chem. Soc., Journ. 95. pp. 1073–1085, June, 1909.)—After preliminary trials three successful experiments were made in which different quantities of emanation yielded by a solution of radium bromide containing 0·2111 gm. of metallic Ra were accurately measured and then compressed in a modified Andrews' apparatus, and their vapour pressure measured at different temperatures. Special care was taken to prevent the emanation coming into contact with grease, for then it apparently dissolves, and pure hydrogen is continuously generated. The liquid emanation is colourless and transparent, like water when seen by transmitted light. It causes phosphorescence of the glass of the tube in which it is contained. The emanation melts at —71° C. The solid emanation glows with a phosphorescence which varies in colour at different temperatures. The vapour pressures of the emanation at different temperatures are as follows :—

Pressure in mm.	Temp., ° Abs.	Pressure in mm.	Temp., ° Abs.	Pressure in mm.	Temp., ° Abs.
500	202·6	5,000	262·8	30,000	346·0
800	212·4	10,000	290·3	35,000	356·0
1,000	217·2	15,000	307·6	40,000	364·4
2,000	234·5	20,000	321·7	45,000	372·9
4,000	255·3	25,000	334·5	47,450	377·5 (Crit.)

Three successful experiments were made upon the volume of the emanation ; the results of these, calculated for the equilibrium quantity obtainable from 1 gm. of Ra metal, are 0·604, 0·606, 0·594 cub. mm. at 0° and 760 mm. : mean = 0·601. This gives a half-life period for radium, on the two assumptions that the half-life period of the emanation is 3·86 days and that the atom of radium as well as that of the emanation is monatomic, of 1,258 years. The volume of the liquid emanation was measured, and the results stated in cub. mm. of gas at 0° and 760 mm. yielded by 1 cub. mm. of liquid are : (1) 461, (2) 636, (3) 535, (4) 623, (5) 447, (6) 631 (near boiling-point of emanation). The mean is 555. The actual volume measured was about 0·00025 cub. mm. The density of the liquid can be calculated only by assuming the density of the gas. Assuming the atomic weight of the gas to be 176 and the density 88, the density of the liquid would be 4·6. The deduction drawn from the results, that the emanation has the atomic weight 176, does not agree with Rutherford's theory regarding the progressive degradation of radium. J. J. S.

1635. *Decomposition of Water by Ultra-violet Rays.* **M. Kernbaum.** (Comptes Rendus, 149. pp. 273–275, July 26, 1909.)—Water previously boiled is placed in a quartz vessel and exposed to the rays emitted by a Heraeus mercury lamp. Using 15 c.cm. of water, the gas set free produces a visible effect on the manometer; the amount liberated appears at first to increase nearly in proportion to the time, and then more slowly. It is proved that the ultra-violet rays decompose water, and that this decomposition can be represented by the equation $2H_2O = H_2O_2 + H_2$, as has been shown to be the case with β-rays of Ra [see Abstracts Nos. 1819 and 1638 (1909)]. We can then admit the existence of a common cause in these two cases. It is supposed that the decomposition in the case of the ultra-violet light is due to the Hertz-effect. C. T. R. Wilson, in 1898, in order to explain the condensation of water-vapour in humid oxygen under the influence of the ultra-violet rays, supposed that the *oxygenated water* formed itself into minute drops. The results of these experiments are in accord with observations made by Schöne in 1874, who found oxygenated water in rain and snow in greater quantity during the day than at night, while he found none in dew.

A. E. G.

1636. *Preparation of Aluminium in the Laboratory.* **S. A. Tucker.** (Electrochem. Ind., N.Y. 7. pp. 315–316, July, 1909.)—An apparatus is described by means of which aluminium can be made on a laboratory scale. A graphite crucible forms the one electrode and a graphite rod the other, the charge consisting of cryolite and alumina. The power circuit should be 110 volts, having a capacity of about 300 amps. 20–30 gm. of Al are obtained after running the apparatus for an hour or an hour and a half. T. S. P.

1637. *Hardness of Magnesium-Silver Alloys.* **W. I. Smirnov** and **N. S. Kurnakow.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. p. 108, 1909.)—The minimum conductivity (36×10^{-4}) for magnesium-silver alloys occurs at the composition Mg_3Ag, with which also corresponds the maximum hardness, 130 kg. per sq. mm. In consequence of the formation by the argentide MgAg of solid solutions with excess of Mg (36–50 per cent. atom Ag) and Ag (50–60 per cent. atom Ag) [compare Żemcżużny, Abstract No. 1799 (1906)], this substance exhibits a relative minimum hardness, namely, 76 kg. per sq. mm. The formation of solid solutions of Mg in Ag [*loc. cit.*] is accompanied by an increase of the hardness from 26 (pure Ag) to 109 kg. per sq. mm. (70·16 per cent. atom Ag). [See also Abstract No. 307 (1909).]

T. H. P.

1638. *Decarburisation of Iron-Carbon Alloys.* **W. H. Hatfield.** (Iron and Steel Inst., Journ. 79. pp. 242–256; Discussion and Correspondence, pp. 257–260, 1909. Abstracts in Engineering, 87. pp. 801–802, June 11, 1909. Metallurgie, 6. pp. 358–363, June 8, 1909.)—The author's view of the decarburisation of cast iron in malleablising is at variance with that of Wüst [see Abstract No. 506 (1908)] in that he finds that the precipitation of temper-carbon before its elimination is not essential. Carbon is eliminated whilst still combined, so that generally the process is as follows: At 750° C. surface oxidation of combined carbon commences. Dissolved carbon diffuses outwards at higher temperatures, and precipitated carbon is redissolved to take its place. F. R.

1639. *Carbon.* **H. le Chatelier** and **Wologdine.** (Comptes Rendus, 148. pp. 1715–1718, June 28, 1909.)—It is concluded that there is no actual experimental proof of the existence of several varieties of amorphous carbon. It is not possible, however, to affirm that varieties do not exist, as determinations of the physical properties are still lacking in precision. The presence of graphite in carbon hitherto regarded as largely or wholly amorphous was detected by treatment with acid, forming graphitic oxide, followed by extremely careful washing, as the oxide is impalpable, and heating, when pyrographitic oxide is recognisable by its bulkiness. In this way graphite was found in soot formed by explosive decomposition of compressed acetylene. Further, the fact that graphite burns less readily than amorphous carbon was used as a means of confirming the result. Lampblack, sugar carbon, wood charcoal, and glow-lamp filaments were found to be free from graphite by dissolving in oxidising chlorate mixture. Different samples of carbon gave densities (by the method mentioned in Abstract No. 882, 1908) from 1·70 to 1·80, but, doubtless owing to the great difficulty of removing the last traces of entrained gas, this method was not sufficiently discriminative as a test for the presence of graphite. The density of amorphous carbon is placed tentatively at about 1·8. F. R.

1640. *Separation of Graphite from White Iron under Pressure.* **G. Charpy.** (Comptes Rendus, 148. pp. 1767–1769, June 28, 1909.)—The author's experiments show that carbon always separates in the form of graphite from white iron or iron carbide (Fe_3C), when heated at temperatures from 700°–1,100°, under pressures up to about 15,000 atmos. F. R.

1641. *Can Cast-structure be Removed by Heating to the Restoring Temperature of Overheated Steel?* **H. M. Howe, W. Campbell,** and **W. T. Koken.** (Amer. Soc. for Testing Materials, Proc. vol. 8, 1908. Metallurgie, 6. pp. 468–469, July 22, 1909.)—The authors consider that the structure of unannealed, hypoeutectic cast steel consists of a network of "primaustenoid" remaining as an unchanged residue from the primarily separated austenite. Primaustenoid is similar in appearance to ferrite, but in an exaggerated form; and whereas primaustenoid is formed from molten solution and consists of a region richer in ferrite than the remaining mass, the ferrite of overheated steel has been rejected in the pure state during cooling from Ar_3 or Ar_{3-2} to Ar_1. The authors' experiments show: (1) That the structure of overheated steel, *i.e.*, steel heated to 1,877° C., is rapidly restored by reheating to just above Ac_3, 804° to 840° C., while after 82 hours' heating at this temperature the structure of cast steel still persisted, a temperature of 1,180° to 1,194° C. being required to restore the structure with any degree of rapidity. (2) The critical temperatures on the first heating of cast steel are the same as those of the same piece after removing the cast-structure. Further experiments are in progress to determine the effect of phosphorus and manganese-sulphide contents on the results. F. C. A. H. L.

1642. *Heat Treatment of Bessemer Steels.* **A. McWilliam** and **E. J. Barnes.** (Iron and Steel Inst., Journ. 79. pp. 848–872; Discussion and Correspondence, pp. 878–882, 1909. Abstracts in Engineering, 87. pp. 770–773, June 4, 1909. Metallurgie, 6. pp. 848–854, June 8, 1909.)—Contains results of mechanical tests on a systematic series of heat treatments of ordinary commercial English acid Bessemer steels of carbon content varying from 0·1 to 0·86 per cent. The tests were carried out on the material, (1) as received; (2) normalised, heated to 950° for 20 min. and cooled in air; (3) annealed, slowly heated and kept at 950° for 35 hours and very slowly cooled in the furnace; (4) quenched from 850° in water and tempered at 400°; (5) quenched from 850° and tempered at 500°; (6) quenched from 850° and tempered at 600°; (7) quenched from 850° and tempered at 700°; (8) quenched from 900° and tempered at 600°; (9) quenched from 900° and tempered at 700°; (10) quenched from 950° and tempered at 700°. It is pointed out that in ordinary hardening it is essential that the piece of steel should be heated to a temperature such that when quenched it will throw off its scale. If any scale remains firmly adhering, whether from the nature of the steel or the temperature used, then it acts as a blanket over the part of the steel it covers, prevents efficient quenching, and the part underneath this scale will be soft. A hardening temperature which results in the steel properly shaling is also in general a temperature that will give efficient quenching. When steels are heated, as in a salt bath, so that no scaling takes place, an efficient quenching temperature seems to be a function of the dimensions of the cross-section of the steels, for steels of the same composition and previous treatment. The paper contains Arnold alternating-stress tests on a series of steels of steadily varying carbon (the first series published), and these seem to prove that only the very mildest steels will pass this test after any system of quenching and tempering tried; further, that the steels as received and normalised are in the best condition with regard to this test, the normalised samples yielding slightly better results. C. O. B.

1643. *Chemical Equilibrium in Metallurgical Reactions.* **R. Schenck.** (Zeitschr. Elektrochem. 15. pp. 584–590; Discussion, p. 591, Aug. 15, 1909. Paper read before the 16th Hauptversamml. d. Deutsch. Bunsen-Gesell., May 24, 1909. Metallurgie, 6. pp. 505–511, Aug. 22, 1909.)—A lecture upon the physical chemistry of the metallurgical oxide and sulphide reduction processes; diagrams are given. In the *discussion*, **E. Jordis** mentions results obtained upon extracting sulphides in a soxhlet. Alcohol and benzol uniformly extract more sulphur than carbon disulphide, and this is stated to be due to the difference between the boiling-points. F. R.

1644. *Conditions necessary to Direct Reactions: Sense of the Electric Current produced when Metals are attacked by Sulphur.* **A. Colson.** (Comptes Rendus, 148. pp. 1183–1186, May 3, 1909.)—Not only do the heats of formation of compounds give no indication concerning their relative stability [Ibid. p. 837 (1909)], but, if two bodies are each capable of combining with a third, the compound formed at any given temperature is not necessarily the one which gives the most heat in its formation. The following results, among others, confirm this principle: When Cu (or Ag) and Al electrodes are placed in yellow ammonium hydrosulphide solution, the direction of the current generated and also the appearance of the Cu (or Ag) show that it is this metal which is attacked by the dissolved sulphur, notwithstanding the fact that the heat of formation of aluminium sulphide is much greater than that of copper or silver sulphide. In addition to the heat evolution, the other conditions influencing direct reactions are the temperature at which the resulting compound begins to form and that at which it begins to decompose. The temperature developed plays a more important part than the amount of heat disengaged. T. H. P.

1645. *Chemical Reactions and Ionisation.* **G. Reboul.** (Comptes Rendus, 149. pp. 110–113, July 12, 1909.)—According to the hypothesis of the electronic constitution of the atom it appears probable that the change of molecular

equilibrium which accompanies all chemical reaction ought to bring about a liberation of electrified centres. It is attempted to demonstrate this experimentally, the apparatus being so arranged that the effect of the chemical reaction can be studied at the instant it takes place. A description and diagram of the apparatus used is given. The reactions studied are divided into four groups: (*a*) Reactions in which no gas is liberated into the surrounding medium, *e.g.*, neutralisation of bases by acids, action of H_2SO_4 on water, double decomposition with formation of a precipitate. No ionisation of the surrounding gas takes place as the result of this class of reaction. (*b*) Reactions accompanied by effervescence or liberation of a gas, *e.g.*, double decompositions with liberation of gas, acids upon metals, water upon anhydrides, &c. There is always an emission of charges of both signs, sometimes symmetrical or with a preponderance of negative, but in general there is a preponderance of positively charged ions. (*c*) Reactions in which the surrounding medium takes part, *e.g.*, phenomena of oxidation in most air, formation of carbonates in CO_2, &c. There is a production of charges of both signs, with in general a preponderance of negative ions. In all reactions of this class the phenomena appear to be of a superficial nature, and always show fatigue. (*d*) Pure gaseous reactions *e.g.*, action of HCl vapour on ammonia vapour, &c. There is a production of charges of both signs, sometimes in large quantities, sometimes only in very small amounts, according to the proportions of the bodies taking part in the reactions. Although the relative number of reactions studied is small, the generalisation is made that in all media in which an overthrow of molecular arrangements takes place there will be electrical conductivity produced. **A. Gautier** in a further note states that the increase in the appearance of vapours which arise from all parts of the crater of the Solfatara at Naples, when a small flame is kindled at one point of the crater, is an example illustrating the preceding. V. Gauthier thinks that this appearance of vapour is due to the ions liberated by the flame, on which the water-vapour, until then invisible, condenses and so becomes visible.
A. E. G.

1646. *Thermal Couples.* **B. J. Kanevskij.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 41. No. 8. pp. 115–130, 1909.)—When a chain of three vessels all containing the same electrolyte, such as normal potassuim chloride solution, and connected by means of siphons, is fitted with electrodes in the two end vessels, one of which is then heated, a current will flow through a wire connecting the two electrodes; the magnitude of the current increases with the difference of temperature of the two electrodes. When the electrodes are of Pt or other indifferent substance, the author terms such a chain a thermal couple of the first order. With a thermal couple of the second order, the electrolyte is a salt of the metal of which the electrodes are composed. To other arrangements the names thermo-liquid couples, thermo-concentration couples, &c., are given. With thermal couples of the first class, the e.m.f. is almost exactly proportional to the temperature-difference between the electrolytes. With couples of the second order, the e.m.f. increases, but not proportionally, with the temperature-difference between the electrolytes. With the thermo-concentration couple, Cu | N/10 . KCl | 3-N . KCl | Cu, the e.m.f. is increased by heating the concentrated potassium chloride solution and diminished by heating the more dilute one; the straight lines representing these changes are approximately equally inclined to the temperature-difference axis. The e.m.f. of the thermo-Daniell couple, Cu | N/10 . $CuSO_4$ | N/10 . $ZnSO_4$ | Zn, rises on heating the copper sulphate solution and falls on heating the zinc sulphate. The production of a current in thermal couples of the first order can be explained only by means of Nernst's theory, the e.m.f. being the result of the difference between the osmotic pressures of the cold and hot solutions. The dependence of the e.m.f. (π) on the temperature-difference ($\tau_1 - \tau_0$) should be expressed by the equation, $\pi = \log [(\tau_0 + \tau_1)/2\tau_0] . K (u - v)(\tau_0\tau_1)/(u + v)(\tau_0 + \tau_1)$, where K is a constant and u and v the velocities of migration of the kathions and anions considered. These velocities not being known for different temperatures, the above equation could not be verified experimentally. T. H. P.

1647. *The Passivity of Iron.* **P. Krassa.** (Zeitschr. Elektrochem. 15. pp. 490–500, July 15, 1909. Paper read before the 16th. Hauptversamml. d. Deutsch. Bunsen-Gesell., May 24, 1909.)—Reviewing previous researches, the author describes new experiments on the passivity of iron in caustic alkali (accumulators); he boils the lye in his cell, a glass beaker. At low temperature the potentials of different sorts of iron—sheet metal, wrought iron, iron wool—differ; at 100° C. they all show about the same potential −1·25 volts; iron wool is strongly active already at low temperature. Iron is in itself capable of decomposing alkali. Iron particles (sheet, filings, nails) were sealed in glass tubes with caustic potash (2- or 3-N), and heated up to 210° C. for 1½ hours, as long as the tubes would stand the heating. The gas liberated was hydrogen and oxygen, the latter partly combined; no gas, or very little, was obtained with the sheet metal. Agreeing with Haber and Goldschimdt, the author ascribes the passivity to the formation of a skin of oxide, which need not at once be visible. A strong current produces passivity immediately, a weak current more slowly. The concentration of the lye does not directly affect the diffusion; but the oxide is more soluble in strong, hot caustic than in weak, cold caustic, and such solutions tend to keep the iron active. The two potential-steps in the discharge curve (which Foerster connects with the formation of different oxides) are not noticed in hot solutions, and it appears probable that the two steps have in hot solution (which contain ferrous oxide, while the skin adhering to the electrode represents a higher oxide) nearly the same energy of formation and may coexist. The optical tests as to the reflecting power of metals and their oxides by Koenigsberger and W. J. Müller cannot be regarded as conclusive. H. B.

1648. *Electrolytic Preparation of the Amalgams of the Alkali and Alkali-Earth Metals.* **G. McP. Smith** and **H. C. Bennett.** (Amer. Chem. Soc., Journ. 31. pp. 799–806, July, 1909. Contribution from the Chem. Lab. of the Univ. of Illinois.)—A new and convenient methed for making amalgams is described. It has the advantages over earlier methods that the apparatus required is very simple and the time required is comparatively short. A suitable quantity of mercury, contained in a 250-c.cm. beaker of internal diam. 5·5 cm., forms the kathode. It is covered with a solution of pure alkali or alkali-earth salt, into which dips a Pt anode. This consists of a piece of heavy foil, bent at a right angle, so that the surface immersed is parallel with that of the mercury. Shortly after starting the electrolysis, crystals of the specifically lighter amalgam begin to cover the surface of the kathode; these can be removed at first by gently agitating the beaker, but as soon as the amalgam becomes pasty they can be pushed underneath the surface by means of a flattened glass rod, bent at a right angle. In some cases the electrolysis can be continued until the amalgam becomes a solid mass of crystals, which can be lifted from the beaker without the separation of the mother-liquor. Directions are given for preparing amalgams of the following metals: caesium, rubidium, potassium, sodium, lithium, barium, strontium, and calcium. The compositions of the amalgams obtained are also given. **T. S. P.**

1649. *Electrolytic Deposition of Alkali Metals from Molten Caustic Alkalies, and Solubility of these Metals in the Melt.* **G. v. Hevesy.** (Zeitschr. Elektrochem. 15. pp. 529–536, Aug. 1, 1909. Extract from Dissertation, Freiburg.) —The author has investigated the solubilities of sodium and potassium in fused caustic soda and potash at different temperatures. The solubility of sodium in caustic soda diminishes as the temperature rises; at 480° C. 100 gm. NaOH dissolve 25·8 gm. Na, whereas at 800° C. only 6·9 gm. are retained in solution. Metals such as Tl, Cd, and Au, which dissolve in Na, lowering its freezing-point, but not in fused caustic soda, diminish the solubility of the Na, the relative diminution in the solubility being in accordance with Nernst's theory. Zinc alloys with Na, but does not lower its melting-point; and as a consequence it does not diminish the solubility of the Na. The solubility of potassium in fused caustic potash varies from 7·8 gm. K in 100 gm. KOH at 480° C. to 0·5 gm. K in 100 gm. KOH at 700° C.; the solubility is not nearly so sharply defined as that of sodium in caustic soda. Experiments on the current-yields at different temperatures showed that at 315°–340° C. caustic soda gave a 27 per cent. yield of Na; the yield diminishes with increase in temperature, becoming nil at 360°–390° C. Caustic potash gave a 55 per cent. yield of potassium at 320–340° C., and this diminished to 26 per cent. at 365–410° C. The poor yields obtained with Na are not due to the solubility of the metal in the electrolyte, but to the diffusion of the metal from the kathode to the anode. At temperatures below 340° C. the velocity of diffusion of Na is very small, but above that temperature it increases rapidly with the temperature. This explains why in the Castner process for making sodium the temperature of the electrolyte must not exceed the melting-point (310° C.) of the caustic soda used by more than 20° C. The rate of diffusion of potassium in potassium hydroxide is very small at all temperatures between 320° and 500° C. The melting-point of anhydrous caustic soda is found to be 327° C. The addition of NaCl, NaBr, or NaI to fused caustic soda has no effect on the solubility of Na in that solvent. **T. S. P.**

1650. *Electrochemical Behaviour of Nickel.* **A. Schweitzer.** (Zeitschr. Elektrochem. 15. pp. 602–610, Aug. 15, 1909. From the Elektrochem. u. physikal.-chem. Laborat. d. techn. Hochschule, Dresden.)—The deposition potential of nickel from solutions of its simple salts, and also the equilibrium potential of Ni in such solutions have been determined. For the deposition potential measurements normal solutions of the chloride and sulphate were used, the necessary hydrion concentration being obtained by the addition of 5 gm. of boric acid per litre. With a nickel chloride electrolyte a nickel anode dissolves quantitatively at the current densities used, whereas with a sulphate electrolyte the anode becomes more or less passive, which results in the formation of free sulphuric acid; sodium acetate was therefore added to diminish the concentration of the hydrion with the latter electrolyte. In all cases the anode consisted of pure electrolytic Ni-foil, the kathode being Pt-foil. During the measurements the electrolyte was vigorously stirred, and oxygen, which influences the potential, was eliminated by using a hydrogen atmosphere and solutions which had been well boiled. Experiments were carried out at 16°, 52°, 75°, and 95° C., and curves are given showing the relation between kathode potential and current density, the kathode potential being referred to the normal calomel electrode (= − 0·283 volt). The results obtained are as follows:—

Electrolyte.	Temp.	Current Density in Amp. × 10^{-4} per cm.^{2}	Kathode Potential.
Nickel Chloride with Boric Acid............	16° C.	From 1·4–182	+ 0·462 to + 0·693 volt.
	52°	„ 0·9–182	+ 0·321 „ + 0·475 „
	75°	„ 22–182	+ 0·281 „ + 0·345 „
	95°	„ 22–182	+ 0·241 „ + 0·275 „
Nickel Chloride with Ammonium Chloride	16°	„ 5·7–45·5	+ 0·500 „ + 0·622 „
	52°	„ 22·5	+ 0·395 volt
	75°	„ 2·6–22·5	+ 0·271 to + 0·315 „
Nickel Sulphate with Boric Acid and Sodium Acetate	16°	„ 8·5–182	+ 0·56(?) „ + 0·771 „
	52°	„ 8–182	+ 0·454 „ + 0·608 „
	75°	„ 22–182	+ 0·426 „ + 0·516 „
	95°	„ 21–182	+ 0·370 „ + 0·444 „

In all cases the current-yields are also given. The results are in fairly good agreement with those obtained by Schoch [Abstracts Nos. 750 and 752 (1909)]; they show that the deposition potential of Ni is much more dependent on the current density than is the case with Cu and other metals. The author considers that this is due to some hindrance to the discharge of nickel ions according to the equation $Ni^{\cdot\cdot} + 2\ominus \longrightarrow Ni$. The relation between anode potential and current density at 16° and 52° was also determined; the anode potential varies more with the current density than does the kathode potential, and the results differ considerably from those of Schoch. The equilibrium potentials were determined in a special apparatus so devised that all oxygen was excluded; before the measurements were made the electrode was kathodically polarised in 20 per cent. caustic potash. The results at 16°(?) C. are:—

Electrode.	Electrolyte.	Potential.
Ni powder	$n/1$ $NiSO_4$	0·880 volt.
	$n/10$ $NiSO_4$	0·848 „
Ni foil	$n/1$ $NiSO_4$	0·807 „
	$n/10$ $NiSO_4$	0·886 „
Ni powder	$n/1$ $NiCl_2$	0·818 „
	$n/10$ $NiCl_2$	0·858 „

These results are different from those of Schoch, who carried out his measurements in an atmosphere of nitrogen. The remainder of the paper is occupied by a discussion of the effect of kathodic polarisation on the equilibrium potential. The author concludes that the equilibrium potential for Ni | $NiSO_4$ lies between + 0·20 and + 0·33 volt. [See Abstract No. 1975 (1907).] T. S. P.

1651. *Attempt to Separate the Alkaline Earth Metals in the Electrolytic Way.* **J. S. Goldbaum and E. F. Smith.** (Amer. Chem. Soc., Journ. 31

pp. 900–902, Aug., 1909.)—Using the method already described for the electrolytic separation of the alkali metals [see Abstract No. 851 (1909)] the authors have found that they can quantitatively separate barium from calcium and strontium from calcium, using solutions of the chlorides. The decomposition potential of strontium chloride was 0·16 volt higher than that of barium chloride, while the decomposition value of calcium chloride was 0·18 volt higher than that of the corresponding strontium salt. Attempts to analyse a mixture containing the chlorides of Ba, Sr, and Ca were not successful, there being no evidence of a change in the decomposition potential corresponding to the change from the Ba-Sr-Ca to the Sr-Ca mixture, similar to that observed, for instance, in the separation of sodium from potassium. [See also Abstracts Nos. 849, 850 (1908).] T. S. P.

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1652. *Improvement in Cells for the Measurement of Osmotic Pressures.* **H. N. Morse** and **B. Mears.** (Amer. Chem. Journ. 40. pp. 266–277, Sept., 1908.)

1653. *Improved Apparatus for Measurement of Transfer Numbers in Solutions of the Halogen Acids.* **E. W. Washburn.** (Technology Quarterly, 21. pp. 164–177, June, 1908. Contribution from the Research Lab. Mass. Inst. of Technology, No. 18.)

1654. *Dynamic Allotropy of Sulphur.* II. **H. R. Kruyt.** (Zeitschr. Phys. Chem. 65. 4. pp. 486–510, Jan. 26, 1909. Van't Hoff Laborat., Utrecht, Nov., 1908.) —A continuation of previous work [see Abstract No. 785 (1909)]. The paper is unsuitable for abstraction and the original must be consulted for details. F. J. B.

1655. *Experiences with the Helberger Transformer Furnace.* **L. Weiss.** (Elektrochem. Zeitschr. 16. pp. 65–67, June, 1909.)—The author gives the results of temperature measurements on the furnace of the firm of H. Helberger, of Munich. The furnace itself is not described. Temperatures higher than 3,000° C. were obtained. 1 kg. of copper could be melted in 4 min. The furnace should be of great use in casting brass, bronze, iron or steel, for melting platinum and iridium, and in the pottery and glass industries. T. S. P.

1656. *Notes on Brass Melting.* **C. T. Bragg.** (Mech. Eng. 24. pp. 81–82, July 16, 1909. Paper read before the Cincinnati Meeting of the Amer. Brass Founders' Assoc.)—Considers in a general manner the manufacture of brass, standardisation of alloys, variations of composition due to oxidation, volatilisation, &c., and gives the methods to be adopted in allowing for melting losses when producing alloys of constant composition. C. O. B.

1657. *Steel Rails.* **J. E. York.** (Amer. Inst. Mining Engin., Bull. 29. pp. 455–467, May, 1909.)—Much the same ground is covered as in the paper dealt with in Abstract No. 315 (1909). A few figures are given as to estimated cost of installation of the author's transverse rolling mills. It is proposed to deduce and control the temperature of rolling, when electric driving is used, from the power record of the motor. F. R.

1658. *Chemistry of Zinc Smelting.* **V. Lepiarczyk.** (Metallurgie, 6. pp. 409–419, July 8, 1909. Communication from the Inst. für Metallhüttenw. a. d. Königl. techn. Hochschule, Berlin.)—An investigation into the roasting and smelting of zinc ores, especially with reference to the effect of Fe, S, $CaSO_4$, &c., and their bearing upon practical results. O. J. S.